PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Includes:

1. Fans and Ventilators.
2. Roof Curbs for Ventilating Equipment.
3. Backdraft Dampers.

1.02 SUBMITTALS

A. Submit in accord with 15010.

B. Product Data

1. All Items Specified Herein.

PART 2 - PRODUCTS

2.01 CEILING-MOUNTING VENTILATORS

A. Description: Centrifugal fans designed for installing in ceiling or wall or for concealed in-line applications.
B. Housing: Steel, lined with acoustical insulation.
C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.
D. Grille designs other than those specified in first paragraph below are available.
E. Grille: Plastic or aluminum, louvered grille with flange on intake and thumbscrew attachment to fan housing.
F. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
G. Accessories:
1. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
2. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
3. Filter: Washable aluminum to fit between fan and grille.
4. Isolation: Rubber-in-shear vibration isolators.
5. Manufacturer's standard roof jack or wall cap, and transition fittings.

H. Certifications:

6. UL 705.
7. AMCA certified ratings seal for both sound and air performance.

I. Approved Manufacturers and Models (Subject to compliance with the above specified requirements. Submittal shall include sufficient information to determine equality.):

1. Greenheck.
2. Cook.
3. Approved equal.

2.02 INTAKE / RELIEF VENTS

A. Construction:

1. Bolted and welded construction utilizing corrosion resistant fasteners.
2. Minimum 14-gauge marine alloy aluminum hood bolted to a minimum 8-gauge aluminum support structure.
3. Aluminum base shall have continuously welded curb cap corners.
4. ½" mesh birdscreen.
5. Engraved aluminum nameplate.

B. Approved Manufacturers and Models (Subject to compliance with the above specified requirements. Submittal shall include sufficient information to determine equality.):

1. Greenheck.
2. Cook – VI (intake) / VR (relief)
3. Approved equal.

2.03 ROOF CURBS

A. Construction:

1. Curbs shall be constructed in accordance with the National Roofing Contractors Association Standards.
2. Roof curbs shall be galvanized steel, insulated, and prefabricated with straight sides suitable for the roof construction used.
3. The curbs shall have 1-1/2 inch or 2-inch insulation complete with solid galvanized steel retainer.
4. Curb shall have a pressure treated wood top rail at least 1-1/2 inches square unless noted otherwise.
5. Provide 22-gage galvanized counterflashing where counterflashing is not provided with unit on curb.
6. Clear inside height shall be a minimum of 14 inches or as noted on the Drawings. Top of curb shall be a minimum of 10 inches above top of finished roof surface as installed. Contractor shall be responsible to select curb heights as required, taking into account thickness of roof construction materials and insulation.
7. Units to set dead level on curb. Refer to Architectural drawings for exact pitch of roof, or obtain actual conditions of existing construction.

B. Approved Manufacturers and Models (Subject to compliance with the above specified requirements.):

1. Roof curb shall be furnished by equipment manufacturer.

PART 3 - EXECUTION

3.01 EQUIPMENT INSTALLATION - GENERAL

A. All equipment shall be set or hung level and securely fastened in place and hung true to building wall lines.

B. All equipment shall be installed per the equipment manufacturer's written recommendations. Provide all necessary support and vibration isolation required.

C. Exact equipment locations shall be coordinated with all other contractors and trades. Any equipment installed without the proper coordination shall be removed and reinstalled at the expense of that Contractor.

D. Rooftop units shall be secured to roof curbs with cadmium-plated hardware.

E. For roof mounted fans, run conduit from inside building, along inside corner of the curb to the junction box.

F. Label fans according to requirements specified in other Division 15 sections.

3.02 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise the field assembly of components and installation of fans, including duct and electrical connections, alignment of fan shaft and motor shaft, alignment of pulleys, belt adjustments, and lubrication, and to report results in writing.

3.03 ADJUSTING AND CLEANING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

D. Clean unit cabinet interiors to remove foreign materials and construction debris. Vacuum clean fan wheel and interior of cabinet.

E. After completing installation, inspect exposed finish. Remove burrs, dirt and construction debris. Repair damaged finishes including chips, scratches and abrasions.

3.04 ROOF-CURB INSTALLATION

A. Roof curbs shall be installed by General Contractor.

B. Flashing and miscellaneous steel framing shall be provided by General Contractor.

C. Mechanically fasten equipment to curb to withstand 110-mph winds.

END 15861

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The extent of ductwork is indicated on the drawings and in the schedules, and by the requirements of this Section.

B. Work Includes:

1. Providing ductwork and ductwork accessories.
2. Installing temperature control dampers furnished by Controls Contractor and specified under Section 15950.
3. Providing required material and final connections to equipment furnished under other sections of these specifications requiring exhaust and ventilation.

1.02 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of ductwork products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Suppliers of duct and fitting components shall provide on request, the following information:

1. Laboratory performance data for duct, including leakage rate, bursting strength, collapse strength, seam strength and pressure loss.
2. Laboratory performance data for fittings.

C. Installer shall be a firm with at least 3 years of successful installation experience on low and/or medium pressure ductwork systems similar to that required for this project.

D. Codes and Standards: The Latest Edition of the following codes and standards apply to all or part of the products or procedures covered in this specification. Individual items of the specification may refer more specifically to applicable sections of these codes or standards. As a minimum, all work shall comply with the applicable section(s) of each of the following:

1. Adhesive and Sealant Council (ASC).
2. American National Standards Institute (ANSI/ASTM).
3. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).
4. Local and State regulations.
5. National Fire Protection Association (NFPA).
6. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA).
7. Standard Building Code.
8. Standard Mechanical Code.

9. Thermal Insulation Manufacturers Association (TIMA).
10. Underwriters Laboratories (UL).
11. Florida Energy Code.

E. Any subsequent alterations to the design must be accompanied by calculations. Field changes to the original design (offsets for interferences, etc.) must be reported to the system engineer.

1.03 SUBMITTALS

A. In accordance with 15010.

B. Shop Drawings

1. Ductwork and Fittings
2. Mechanical Room Layouts

C. Product Data

1. All items specified herein.

1.04 PRODUCT HANDLING

A. Protect ductwork, accessories and purchased products from damage during shipping, storage and handling. The Contractor shall make provisions for the storage of fiberglass and lined sheet metal ductwork in an enclosed trailer, when stored on-site and prior to building "dry-in", to prevent any damage resulting from inclement weather or construction traffic. Ductwork shall not be stored outdoors.

B. Ductwork, stored or installed, found to be damaged as a result of moisture; vandalism, carelessness or construction traffic shall be replaced in new condition by the Contractor, to the satisfaction of the Owner and at no additional expense. There will be no exceptions.

1.05 QUALITY ASSURANCE PROCEDURE - DUCT SYSTEMS

A. The following procedures are required as a minimum to keep the ductwork clean, as required by the Specifications:

1. Stored ductwork shall be sealed with Visqueen on each end of each piece of duct and shall be covered with Visqueen at all times during storage periods to keep dust from entering the ductwork system.
2. Prior to installation, Contractor shall inspect the ductwork and wipe the inside surfaces of duct clean, if necessary.
3. Upon installation of each section of the ductwork, all outlets shall be covered with Visqueen and taped shut to keep construction dust from entering the ductwork once it is installed. This procedure shall be carried out the same day the ductwork is installed. Duct joints shall be sealed as soon as possible.

4. Ductwork shall be periodically checked by Contractor during course of construction to insure that protective Visqueen remains sealed around all openings of the ductwork.
5. Protective measures shall be taken to keep HVAC units from operating during periods of high levels of construction dust, such as concrete cutting, drywall sanding, etc.
6. HVAC filters shall be installed at all air handling units, return air duct openings and filterback grilles. HVAC filters shall be of design quality and performance and shall be inspected no less than a monthly basis and changed out. During periods of high construction dust, filters are required to be changed out as much as once per week, depending upon visual inspection and the amount of run time of the unit.
7. After completion of installation, the interior walls of ductwork and interior components and walls of air handlers shall be inspected for dirt and dust by Contractor, Architect, Engineer and Owner. If unacceptable amounts of dust and dirt are visible, the unit and ductwork shall be cleaned and tested by Contractor to meet the requirements of the Specifications and NADC 1992-01 "Mechanical Cleaning of Non-Porous Air Conveyance System components", at no additional cost to the Owner.
8. For ductwork systems already installed, duct shall be cleaned and Visqueen installed on all openings (including openings with dampers) to keep future construction dust from entering the system.

PART 2 - PRODUCTS

2.01 DUCTWORK

A. Galvanized Sheet Metal

1. ASTM A653, Lock-forming Quality
2. Coating G-90 (0.90 oz./S.F.)
3. The weight of steel used shall not be less than is listed in the SMACNA manual "HVAC Duct Construction Standards", Latest Edition. Minimum operating static pressure is as follows:

   a. Low Pressure Supply: +2.0"
   b. Return: -2.0"
   c. Exhaust: +/-2.0"

4. See SMACNA manual for gage and reinforcement requirements and provide all as required.

B. Fiberglass Rigid Board Duct shall NOT be used as an air conveyance system. Rigid duct board may be used only as an external insulation material.

C. Flexible Duct – Low Pressure

1. U.L. listed as Class I duct and connector, Standard 181 and shall comply with NFPA 90A.

2. Duct shall have an inner liner of a trilaminate fabric of aluminum foil, fiberglass and aluminized polyester.
3. The flexible duct shall have an exterior jacket of fiberglass insulation (min. 1") enclosed in a reinforced metalized protective vapor barrier.
4. Inner liner shall be mechanically joined to corrosion resistant coated steel helix.
5. Minimum pressure rating shall be 12" w.g. positive and 5" w.g. negative.
6. Maximum thermal conductivity of 0.23 at 75 degrees F, and vapor barrier permeance of 0.05 Perm per ASTM E96, Procedure A.
7. Provide flexible duct of the size shown on the Drawings.
8. The Contractor shall provide all necessary transitions required between air devices and ductwork.
9. Approved Manufacturers: Subject to compliance with the above specified requirements.

    a. Flexmaster - Type 3M
    b. Approved Equal

D. Flexible Duct – Medium/High Pressure/Return

1. U.L. listed as Class I duct and connector, Standard 181 and shall comply with NFPA 90A.
2. Duct shall be constructed of .005 inch thich 3003-H14 aluminum alloy in accordance with ASTM B209.
3. Duct shall be sprial wound into a tube and spiral corrugated to provide strength and flexibility.
4. Minimum pressure rating shall be 10" w.g. positive and 12" w.g. negative.
5. Maximum thermal conductivity of 0.23 at 75 degrees F, and vapor barrier permeance of 0.05 Perm per ASTM E96-66, Procedure A.
6. Provide flexible duct of the size shown on the Drawings.
7. The Contractor shall provide all necessary transitions required between air devices and ductwork.
8. Approved Manufacturers: Subject to compliance with the above specified requirements.

    a. Flexmaster - Type TL-M
    b. Approved Equal

2.02 FLEXIBLE CONNECTIONS

A. Interior flexible connections for ducts shall be glass fabric, double coated with Neoprene.

B. Exterior applications use a flexible duct connection of glass fabric double coated with Hypalon.

C. Submit manufacturer and model for review and approval.

2.03 DUCT TAKE-OFFS (Round, from Rectangular Sheetmetal Ducts)

A. For branch ducts serving only one diffuser/grille, round take-offs from rectangular sheetmetal ducts shall have the following features:

1. 45 degree entry
2. Minimum 26 gauge, G-90 galvanized steel construction
3. 1" wide mounting flange with die formed corner clips
4. Prepunched mounting holes
5. Adhesive coated gasket for minimal leakage
6. Round outlet shall be provided with rolled stiffener bead.
7. Provide with volume damper with 2" insulation build-out, 3/8" square shaft, nylon bushings and Duro Dyne KR-3 locking quadrant handle.

B. Approved Manufacturers and Models: Subject to compliance with the above specified requirements.

1. Flexmaster U.S.A., Inc.- Model "STOD" with insulation build-out option "BO3"
2. Approved Equal

2.04 VOLUME DAMPERS

A. Volume dampers shall have the following features:

1. The damper blade shall be fixed to the damper rod so that the damper blade cannot move independently of the rod.
2. The damper blades shall be of a single thickness of metal at least two gauges heavier than adjacent ductwork and have the edges hemmed.
3. Handles shall be locking quadrant type and clearly indicate damper position. Ends of the damper shaft shall be notched parallel to damper position. Provide stand offs and extended rods for insulated ducts as required. (Note: Volume damper handles utilizing a wing nut on the end of the shaft, at the center of handle rotation, are NOT permitted.)
4. Dampers shall be properly fabricated to prevent vibration. Contractor shall select dampers accordingly for the maximum air velocity and duct gauge encountered at each location.
5. For rectangular dampers, maximum single blade dimension perpendicular to the axis of rotation shall be 8". Opposed blade dampers shall be used for duct sizes exceeding this dimension, and where indicated on the drawings.
6. All dampers shall meet or exceed the requirements indicated in the SMACNA "HVAC Duct Construction Standards", Section 2.2 "Volume Dampers".

B. Approved Manufacturers: Subject to compliance with the above specified requirements.

1. Ruskin
2. Krueger
3. Air Balance

4. Vent Products

PART 3 - EXECUTION

3.01 DUCTWORK AND MECHANICAL ROOM SHOP DRAWINGS

A. The Contract Documents are design drawings, not fabrication and installation drawings. They are diagrammatic in nature and therefore do not indicate all offsets and fittings that may be necessary to complete the ductwork systems. The bidder is to assume, and include in his bid, all necessary transitions, offsets and fittings to complete the duct systems and shall indicate same in ductwork shop drawing package.

B. Prior to fabrication and installation, the Contractor shall submit ductwork shop drawings. Minimum scale shall be 1/4"=1'0". Submit dimensioned layouts showing both the accurately scaled ductwork and its relation to space enclosure. Show modifications of indicated requirements, and how those modifications ensure that free area, materials and rigidity are not reduced. Show duct gauge sizes, hanger methods, insulation size and type and duct joint connection details. Show duct elevation dimensions in relation to floor, ceiling and structural heights. Indicate all ductwork accessories, mechanical equipment, air devices, etc. on shop drawings. Locate all duct heaters, VAV boxes, power ventilators, air handling equipment, smoke detectors, in fully accessible locations as they relate to lights, joists, beams, sprinkler mains, etc. to ensure safe unrestricted access for service and maintenance. These drawings shall be coordinated with all other subcontractors and the General Contractor and will serve as a part of the coordination and layout drawings required under Section 15010 for all systems.

C. The shop drawings shall indicate as-installed conditions and shall be coordinated with the work of all other trades, and any existing conditions of the site.

D. Mechanical room detail drawings shall be 1/2 inch = 1 foot scale (minimum) and shall show the layout of all equipment, fixtures, ducts, piping and associated electrical and control equipment. Piping shall be drawn to scale (double line) and shall show locations of all valves and piping specialties. Layout shall permit required accessibility for service and maintenance.

E. Details of duct fittings shall be submitted and after review and approval shall serve as comparison guidelines for the actual construction.

3.02 DUCTWORK SERVICE SCHEDULE

A. Galvanized Steel

1. Low pressure supply air
2. Return air
3. Outdoor air (ventilation)
4. Exhaust (non-grease, non-corrosive)

B. Flexible Duct – Low Pressure

1. Where shown (or noted) on the drawings.
2. All flexible ducts shall be suitable for the service intended.
3. No length of flexible duct shall be over 8 feet long or turn more than a total of 180 degrees.
4. From branch ductwork to diffusers.
5. Only in concealed spaces (above ceilings).
6. Shall not be used on the inlet of VAV boxes.

C. Fiberglass rigid board duct shall not be used as an air conveyance system. Rigid duct board may be used only as an external insulation material.

D. Refer to Section 15250 for insulation requirements and note ductliner requirements specified herein.

3.03 SHEET METAL DUCTWORK

A. The Contractor shall furnish and install all ductwork required in connection with the Air Distribution and Exhaust Systems.

B. All sheetmetal ductwork shall be constructed and installed in accordance with SMACNA manual titled "HVAC Duct Construction Standards - Metal and Flexible".

C. The internal dimension of all ducts shall be of size indicated on the drawings. In no case shall the Contractor change the indicted size of the ductwork without written approval of the Architect/Engineer.

D. The Contractor shall carefully check the arrangement of ducts and dimensions of all working spaces at the building so that there will be no interference with the running of ducts. The Contractor shall carefully lay out all openings in floors and walls.

E. All ductwork shall be securely supported and shall be installed so as not to interfere with plumbing and piping and electric light outlets.

F. Where ducts pass through finished walls, fire walls or smoke partitions, or floors, galvanized angle frames at the walls, floors, and ceilings shall be provided by the Contractor to seal the space around the duct. See Section 15050.

G. Turns in ducts to be constructed with easy turns and under no circumstances shall a curve be made having a radius less than twice the width of the duct for ducts up to twelve inches wide, and less than the width of the duct for larger ducts.

H. Wherever it is necessary to change the shape of the ducts, it shall be done gradually and the full area retained.

I. Manufactured acoustical air foil turning vanes shall be used wherever mitred turns or square turns are installed.

J. Where required for access to equipment, dampers and/or controls, provide duct mounted access panels (doors). Panel size shall be sufficient for access to accommodate required servicing. The panels shall be a standard product of a company engaged in the manufacturing of access panels and shall be complete with frame, insulated door, gasket(s) and latches.

3.04 SEALING DUCTS

A. As a minimum, seal all lateral and longitudinal joints in all ducts according to SMACNA Seal Class A unless otherwise noted on drawings or specified herein.

B. Lock all seams in ductwork and hammer flat; make absolutely tight against air leakage. Lap joints with inside lap in direction of air travel. Install sufficient slip joints in the ducts to take care of expansion and contraction.

3.05 DUCTWORK TAKE-OFFS

A. Provide take-offs from the supply mains where indicated on the drawings. Take-offs shall be of an appropriate design for the main duct construction.

B. For all branch ducts, provide 45 degree entry boot taps as indicated on drawings. Volume dampers shall be provided at each takeoff and where indicated.

3.06 VOLUME DAMPERS

A. Furnish and install volume dampers where shown on the drawings, and as required to properly equalize and balance the ventilating systems.

B. As a minimum, dampers must be provided to isolate and adjust flow at each individual supply, return and exhaust air device connection to a duct. This applies whether or not a damper is specifically shown or noted in each location on the drawings.

C. Each branch duct (duct serving multiple air devices) shall be provided with a volume damper minimum two gauges heavier than the duct. Damper shall be located at the branch duct connection to the main duct.

D. All dampers shall be so constructed that there will be no movement of the damper blades or assembly when the systems are in operation.

E. Standoffs and extended rods to set the damper operator (handle) beyond the duct insulation shall be provided, as required.

3.07 DUCT MOUNTED SMOKE DETECTORS

A. Install duct mounted smoke detectors furnished by the project Electrical Contractor.

3.08 DUCT CONNECTIONS

A. Where metal ducts are to be connected to air handling units or fans, flexible connections shall be used.

3.09 HANGERS AND SUPPORTS

A. All horizontal suspended ducts shall be supported with galvanized steel angle trapeze hangers around side and bottom of ducts, and securely fastened to the building construction in an approved manner.

B. Horizontal duct supports are to be spaced not more than five feet apart.

C. Ducts eighteen inches or less in width may be provided with strap steel trapeze hangers around sides and bottom of ducts in lieu of steel angles.

D. Round and oval duct shall be supported as shown on the drawings or as recommended by SMACNA Manual.

E. No ceilings, piping or equipment shall be supported from the ductwork or duct hangars.

F. For roof mounted ductwork, as a minimum, horizontal duct supports shall be pier or curb base with cap flashing and galvanized steel angle supports. Ducts shall be securely fastened to the supports. All supports shall be installed into roofing system watertight, and shall be securely attached to building structure. All associated roof work shall be included in Contractor's bid. See drawings for more restrictive requirements. The use of wood for supporting ducts will not be permitted.

3.10 DUCT WALL PENETRATIONS

A. Noncombustible Duct Penetrations Consist Of:

1. 3" high (maximum), 24 gauge galvanized duct collar both sides of the floor or wall.
2. Annular space filler.
3. Annular Space Filler For Ducts

    a. All Walls and Floors

        1) Fire rated caulking compound designed expressly for this purpose.

4. Approved Manufacturers and Models: Subject to compliance with the above specified requirements.

    a. Dow Corning - Fire Stop
    b. Standard Oil Engineering Materials Co. - Fyre Putty
    c. 3M - Fire Barrier

B. All Other Duct Wall Penetrations

1. Duct penetrations consist of:

   a. Finished and unfinished spaces 3" high (maximum) 24 gauge galvanized duct collar both sides of wall.
   b. 1/2" annular space between duct and wall.

3.11 COORDINATION WITH OTHER CONTRACTORS

A. This Contractor shall coordinate installation of mechanical equipment and ductwork with the building structural system, walls, ceilings and finishes (General Contractor) to insure service and maintenance accessibility to equipment is not impaired.

B. This Contractor shall coordinate installation of mechanical equipment and ductwork with the routing of conduit by the Electrical Contractor to insure service and maintenance accessibility to equipment is not impaired.

C. Any equipment, fixtures or material installed without the proper coordination shall be removed and reinstalled at the expense of the Contractor.

D. Access doors shall be provided in walls and ceilings for proper access, adjustment, and service to all ductwork and ductwork accessories.

END 15890

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Extent of air devices (outlets and inlets) is indicated by drawings and schedules, and the requirements of this section.

B. Air outlets and inlets required for this project include:

1. Diffusers.
2. Registers and grilles.
3. Louvers.

C. Work Includes:

1. Providing all air devices required.
2. Providing required material and final connections to ductwork and equipment furnished under the other sections of these specifications.

1.02 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of air devices of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installers: Firms with at least 5 years of successful installation experience on projects with work similar to that required for this project.

C. Codes and Standards: The following codes and standards apply to all or part of the products or procedures covered in this specification. Individual items of the specification may refer more specifically to applicable sections of these codes or standards.

1. Air-Conditioning and Refrigeration Institute (ARI). ARI 650.
2. Air Diffusing Council (ADC), ADC 1062. Provide ADC Certified Rating Seal.
3. Air Movement and Control Association (AMCA), AMCA 500. Provide AMCA Certified Rating Seal.
4. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). ASHRAE 70.
5. National Fire Protection Association (NFPA). NFPA 90A.

1.03 SUBMITTALS

A. In accordance with 15010.

B. Submit manufacturer's technical product data for each type of air device including model number, accessories furnished, construction, finish, and mounting details. Submit performance data, and noise criteria readings. Indicate selections on data.

C. Submit a detailed schedule similar to schedule shown on drawings showing pressure drop, throw, accessories, etc.

D. Submit manufacturer's assembly-type shop drawings for each type of air device.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver air devices wrapped in factory-fabricated fiber-board type containers. Identify on outside of container type of outlet or inlet and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.

B. Store air devices in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.01 CEILING AIR DIFFUSERS

A. Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity and type scheduled and/or noted on the drawings; constructed of materials and components as indicated, and as required for complete installation.

B. Contractor shall furnish any required adapters, transitions, or other accessories as required to mount devices, or connect to specified duct systems, whether or not indicated on the drawings or specified herein.

C. Diffusers shall be aluminum construction, except as noted, and except devices used in the ceiling portion of a rated floor/ceiling assembly shall be steel.

D. Diffuser finish shall be as scheduled on the drawings or as selected by the Architect/Engineer.

E. Provide ceiling air diffusers that have, as minimum, temperature and velocity traverses, throw and pressure drop, and noise criteria ratings for each size device as listed in manufacturer's current data in accordance with ARI Standards.

F. Provide diffusers with border styles that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems, which will contain each type of ceiling air diffuser. Field verify existing conditions and ceiling type for renovation work that does not require complete ceiling replacement.

G. Diffusers shall be supplied with color matched screws and with sponge rubber gaskets for airtight installation (when required).

H. Flanged frame diffusers shall be supplied with color matched countersunk sheet metal screws.

I. Approved Manufacturers: Subject to compliance with the above specified requirements.

1. Titus
2. Carnes Company
3. Metal-Aire
4. Krueger Manufacturing Co.
5. Approved Equal

2.02 REGISTERS AND GRILLES

A. Except as otherwise indicated, provide manufacturer's standard registers and grilles where shown; of size, shape, capacity and type scheduled and/or noted on drawings; constructed of materials and components as indicated, and as required for complete installation.

B. Contractor shall furnish any required adapters, transitions, or other accessories as required to mount devices, or connect to specified duct systems, whether or not indicated on the drawings or specified herein.

C. Registers and grilles shall be aluminum construction, except as noted and except devices used in the ceiling portion of a rated floor/ceiling assembly shall be steel.

D. Register and grille finish shall be as scheduled on the drawings or as selected by the Architect/Engineer.

E. Provide registers and grilles that have, as minimum, temperature and velocity traverses, throw and pressure drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

F. Provide registers and grilles with border styles that are compatible with adjacent wall or ceiling systems, and that are specifically manufactured to fit into wall or ceiling construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of wall or ceiling construction which will contain each type of register and grille. Field verify existing conditions where devices will be mounted in existing wall or ceiling.

G. Registers and grilles shall be supplied with color matched screws and with sponge rubber gaskets for airtight installation.

H. Flanged frame registers and grilles shall be supplied with color matched countersunk sheet metal screws.

I. Approved Manufacturers: Subject to compliance with the above specified requirements.

1. Titus
2. Carnes Company

3. Metal-Aire
4. Krueger Manufacturing Co.
5. Approved Equal

2.03 LOUVERS

A. Except as otherwise indicated, provide manufacturer's standard louvers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated and as required for complete installation.

B. Provide louvers that have the minimum free area, and maximum pressure drop for each type as listed in manufacturer's current data, complying with louver schedule and/or notes.

C. Provide louvers with frame and sill styles that are compatible with adjacent substrate, and that are specifically manufactured to fit into construction openings with accurate fit and adequate support, for weatherproof installation. Refer to general construction drawings and specifications for types of substrate which will contain each type of louver. For existing building installation, Contractor shall field verify substrate construction, and provide louvers accordingly.

D. Construct of aluminum extrusions, ASTM B 221, Alloy 6063-T52. Weld units or use stainless steel fasteners. Louvers shall have the following construction, unless noted otherwise.

1. Shall be storm proof, drainable type.
2. Frame and Blades: .125 and .081 inch thick extruded aluminum respectively.
3. Finish: As scheduled on the drawings or selected by the Architect/Engineer.
4. Mullion: Exposed (used only on louver widths over 60 inches).
5. Screens: On inside face of exterior louvers, provide 1/2" square mesh anodized aluminum wire bird screens mounted in removable extruded aluminum frames.

E. Provide extruded aluminum brick or block vents with mesh insect screen where indicated on the drawings.

F. Approved Manufacturers: Subject to compliance with the above specified requirements.

1. Ruskin ELF-6375DxD
2. Air Balance
3. Construction Specialties
4. Penn Ventilator Co.
5. Metal-Aire
6. Approved Equal

PART 3 - EXECUTION

3.01 COORDINATION AND INSPECTION

A. This Contractor shall coordinate installation of air devices with the building structural system, walls, ceilings and finishes (General Contractor) to insure service and maintenance accessibility to equipment is not impaired.

B. This Contractor shall coordinate installation of air devices with the routing of conduit by the Electrical Contractor to insure service and maintenance accessibility to equipment is not impaired.

C. Any air devices installed without the proper coordination shall be removed and reinstalled at the expense of the Contractor.

D. Examine areas and conditions under which air outlets and inlets are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION - GENERAL

A. Install air devices in accordance with manufacturer's written instructions and in accordance with recognized industry practices to insure that products serve intended functions.

B. Coordinate with other work, including ductwork and duct accessories, as necessary to interface installation of air outlets and inlets with other work.

C. Spare Parts: Furnish to Owner, with receipt, three operating keys for each type of air outlet and inlet that requires them.

3.03 DIFFUSERS, REGISTERS AND GRILLES

A. Install diffusers, registers and grilles where shown on architectural reflected ceiling drawings or where directed by Architect/Engineer. Unless otherwise indicated, locate units in center of acoustical ceiling modules.

B. Install diffusers, registers and grilles in a manner that they will be vibration free during operation. Insulate neck (throat) and back of diffuser, to prevent condensation.

C. Pattern controllers and dampers shall be set and adjusted as required for desired air distribution patterns and airflow rates. Adjust throw not to exceed velocities of 50 FPM at a height 6 ft. above floor level in occupied zones. Adjustable blades shall be straightened and made parallel to each other.

3.04 LOUVERS

A. Wall opening and lintel will be provided by the General Contractor. This Contractor shall be responsible for size of opening and details to assure proper fit.

B. Louver frame shall be of the type as required to suit the respective wall opening and sill conditions. Refer to the architectural drawings and coordinate with the General Contractor as required.

C. Provide caulking, flashing, counterflashing, mounting hardware, etc. as required for a secure and weather tight, installation. Any mounting screws exposed on exterior shall be vandal proof type and corrosion resistant.

D. Where aluminum and black steel come into contact in this installation, the steel must be painted or coated with bitumastic in an approved manner.

END 15932

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Includes:

1. Testing, adjusting and balancing of all air systems.

1.02 JOB CONDITIONS

A. Heating, ventilation, and air conditioning equipment shall be completely installed and in continuous operation to accomplish the testing, adjusting and balancing work specified. Complete air balancing prior to hydronic balancing.

B. Perform testing, adjusting and balancing when outside conditions approximate design conditions for heating and cooling functions or when the system is operating at design capacity.

C. Notify the Owner in writing when the testing and balancing work will begin. The Owner reserves the right to have an observer present during the times when the testing and balancing work is being performed.

1.03 QUALITY ASSURANCE

A. The Balancing Agency shall have been in business continually for a minimum of the previous five (5) years.

B. Only Qualified Personnel shall perform testing and balancing work. Qualified Personnel are defined as personnel who possess current, applicable certification(s) by at least one (1) of the following organizations:

1. AABC – Associated Air Balance Council
2. NEBB – National Environmental Balancing Bureau

C. The balancing agency shall have a minimum of one (1) qualified test and balance engineer having applicable certification referenced above. This certified test and balance engineer shall be responsible for on-site supervision of the work, and subsequent certification of the report specified herein. This individual shall have at least five (5) years applicable experience.

D. Submit a list of at least five (5) completed projects of similar type, size, and scope to this project successfully tested and balanced by the submitted Qualified Personnel for review by the Architect/Engineer, prior to performing the work.

E. Each Contractor shall perform all corrective measures caused by faulty installation. Retest, readjust and rebalance system(s) until satisfactory results are achieved.

F. The balancing agency shall perform the services specified herein in accordance with AABC or NEBB Standards. If the specifications herein are more stringent than those of AABC or NEBB, the more stringent specifications shall prevail.

1.04 SUBMITTALS

A. Submit in accord with 15010.

B. Prior to performing the work, submit all data necessary, for Architect/Engineer review, to establish that the qualifications and requirements indicated above in Paragraph 1.03 "Quality Assurance" are met by the Balancing Agency and its associated Qualified Personnel.

C. Prior to performing the work, submit Data Sheet on each item of testing equipment for Architect/Engineer review. Include name of device, manufacturer's name, model number, latest date of calibration and correction factors. Calibration of all testing equipment shall be within a period of six (6) months prior to their use on this project, in accordance with NEBB or AABC standards and the instrument manufacturers.

D. Submit a Certified Report containing all test data and other related information recorded during testing and balancing, placed on appropriate NEBB or AABC forms for Architect/Engineer review. This does not preclude computer generated forms that follow NEBB or AABC guidelines. All forms shall be modified as required to contain the information specified herein. Reports shall certify that the methods used and results achieved are as specified. Reports shall note all discrepancies from design and reasons for such discrepancies.

1.05 MECHANICAL CONTRACTOR'S RESPONSIBILITIES

A. The Mechanical Contractor has numerous responsibilities associated with the test and balance. It is imperative that the Test and Balance Contractor coordinate these responsibilities with them.

B. Allocate time in the construction schedule for test and balance procedure.

C. Place all systems and necessary allied devices required and only those required, for each working day of the testing and balancing procedures into maximum design condition operation. At the completion of the testing and balancing procedures of the day, the Mechanical Contractor shall return the systems to normal operation or shut them down.

D. Replace and/or install pulleys, belts, and dampers as required for the correct balance as directed by the Test and Balance Contractor.

E. Prepare the airside systems for testing and balancing as follows, (all new and existing devices are included).

1. Mechanically check all rotating air devices, to insure that the devices are capable of operation under normal design modes and have correct rotation and the related automatic controls are functional and calibrated.
2. All balancing, splitter, volume, fire and smoke control, and VAV dampers shall be in their respective neutral position or fully open. All locking devices shall be functional and secured.
3. All air distribution inlet and outlet devices (i.e., grilles, registers, diffusers, and etc.) shall be fully open. All locking devices shall be functional and secured.
4. All automatic controls (i.e., direct digital, electronic, electric, pneumatic, hydraulic and/or any combination thereof) shall be mechanically and electrically checked and be available to operate under design conditions.
5. Air control locking devices (i.e., control rods, quadrants, and etc.) shall be permanently marked to represent the true position of their respective control surfaces. The locking devices markings shall be inconspicuous in occupied areas.
6. Install new air filters before the start of testing and as directed by the Test and Balance Contractor in order to meet design conditions of the air handling devices.
7. Provide air control devices, such as balancing dampers, as per the drawings and specifications, and as directed by the Test and Balance Contractor in order to obtain the proper balance conditions.

1.06 REVERIFICATION

A. A percentage (not more than 5%) of the final recorded data will be subject to reverification by the Architect/Engineer or Owner. This Contractor shall take instrument readings as directed. Test points will be in normally accessible locations and randomly selected by Architect/Engineer. If these random tests demonstrate a measured flow deviation of 10 percent or more from that data recorded in the certified test and balance report, all systems shall be retested and readjusted, and a new certified report submitted, at no additional cost.

PART 2 - PRODUCTS

Not Applicable To This Section.

PART 3 - EXECUTION

3.01 AIR SYSTEMS

A. Test, adjust and balance systems in accord with the following requirements:

1. Preliminary:

a. Identify and list size, type and manufacturer of all equipment to be tested including air terminals. Inspect all system components for proper installation and operation.
b. Use manufacturer's ratings for all equipment to make required calculations except where field test shows ratings to be impractical.

c. Verify that all instruments are accurately calibrated and maintained.
d. Install clean filters.

2. Central System

a. Test, adjust and record fan RPM to design specification within the limits of mechanical equipment provided.
b. Test and record motor voltage and running amperes including motor nameplate data and starter heater ratings.
c. Make pitot tube traverse of main supply, and exhaust ducts, determine and record CFM at fans and adjust fans to design CFM.
d. Test and record system static pressure, suction and discharge.
e. Test and adjust system for design outside air, CFM, using pitot-tube traverse.
f. Test and adjust systems for design recirculated air, CFM, using pitot-tube traverse.
g. Test and record heating apparatus entering air temperatures, dry bulb.
h. Test and record cooling apparatus entering air temperatures, dry bulb and wet bulb.
i. Test and record heating apparatus leaving air temperatures, dry bulb.
j. Test and record cooling apparatus leaving air temperatures, dry bulb and wet bulb.

3. Distribution: Adjust zones or branch ducts to proper design CFM, supply and return.

4. Air Terminals (Diffusers, Registers, Grilles, Central Dampers):

a. Identify each air terminal from reports as to location and determine specified flow reading.
b. Test and adjust each air terminal to within 5% of design requirement.
c. Test procedure on air terminals shall include comparison of specified FPM velocity and observed velocity, adjustment of terminal, and comparison of specified CFM and observed CFM after adjustment.
d. Adjust flow patterns from air terminal units to minimize drafts to extent design and equipment permits.

5. Heaters:

a. Measure and record KW, volts and amps.
b. Measure and record air temperature rise (°F).

6. Verification:

a. Prepare summation of readings of observed CFM for each system, compare with required CFM and verify that duct losses are within specified allowable range. Determine coil and filter static pressure drops.
b. Verify design CFM at fans as described in 3.01.A.2.c. above.

3.02 SPLIT SYSTEM TESTS

A. Test, adjust and balance systems in accord with the following requirements.

1. Record unit data including mark, location, manufacturer model number and serial number of all equipment tested.

2. Measure and Record Evaporator Fan and Motor Data (Design and Actual)

   a. Motor manufacturer, nameplate HP, volts, amps, phase, RPM and service factor.
   b. Sheave diameters and number; type , and size of belts.
   c. Supply, return, and outside air CFM.
   d. Fan RPM.
   e. Motor volts and amps.
   f. Fan total, suction, discharge, and unit external static pressure.

3. Measure and Record Evaporator Coil Data (Design and Actual)

   a. Coil CFM.
   b. Coil entering and leaving air DB/WB temperatures, °F.
   c. Coil capacity, BTUH.

4. Measure and Record Condensing Unit Data (Design and Actual)

   a. Manufacturer model number and serial number.
   b. Number of compressors/circuits.
   c. Ambient temperature, °F.
   d. Crankcase heater volts, amps.
   e. Compressor volts, amps.
   f. Condenser fans: number, HP, volts, amps, phase, RPM.

5. Measure and Record Heater Data

   a. Measure and record KW, volts and amps.
   b. Measure and record air temperature rise (°F).

3.03 ELECTRIC HEATING EQUIPMENT:

A. Test and record voltage and amperage readings at each electric heater while fully energized.

3.04 SYSTEM PERFORMANCE REPORT:

A. After the conclusion of balancing operations, make temporary installation of portable recorders and simultaneously record temperatures and humidity during summer and winter conditions at representative locations in each system outside and inside of building.

B. Architect/Engineer will direct test locations.

C. Make recordings during summer and winter for a seven-day period, continuous over a weekend and including at least one period of operation at outside conditions within 5 °F. wet bulb temperature of maximum summer design condition and within 10 °F. dry bulb temperature of minimum winter design condition.

D. Report of test results shall include original recording and two reproductions.

3.05 SUBMISSION OF REPORTS

A. Fill in test results on approved NEBB or AABC forms.

B. Submit three certified copies of specified test reports to the Architect/Engineer for review.

C. Include in report a list of instruments used and last date of calibration.

END 15991

PART 1 – GENERAL

1.01 DESCRIPTION

A. The work included consists of all supervision, labor, materials, equipment, facilities and installation required for the complete, satisfactory and approved Electrical Systems as indicated on the Contract Documents and called for in this Specification, or as may be reasonably implied by either for the installation of a complete Electrical System.

B. All notes on the Drawings pertaining to the work of this Trade shall be considered as part of this Specification and Contract.

C. In general, the Electrical Contractor shall make final connections to equipment furnished by other trades or by owner.

D. Refer to entire Contract Documents for coordination and demolition.

E. Contractor shall confirm existing utilities are capped or shutdown prior to excavation or demolition.

F. Contractor must notify Owner two weeks (14 calendar days minimum) prior to excavation and exercise due caution with regard to disturbance of utilities and service.

G. Contractor shall be held responsible for any damage and restoration to utilities and services. Restoration shall be made expeditiously with methods and materials that are approved for the intended use. Provide written report to the Owner detailing occurrence and corrective action.

H. Contractor must coordinate and include with bid all indicated service requirements including site installation.

I. The locations of existing underground utilities are shown in an approximate way only and have not been independently verified by the Owner or its representative. The Contractor shall determine the exact location of all existing utilities before commencing work, and agrees to be fully responsible for any and all damage which might be occasioned by the Contractor's failure to exactly locate and preserve any and all underground utilities. Contractor is responsible for including all demolition and reroute, reinstallation costs in bid.

J. It is the Contractor's responsibility to visit the job site to inspect and confirm field conditions and systems. Advise Consultant of inconsistencies prior to bidding (14 calendar days minimum).

K. The Contractor shall install complete and operating Electrical Systems consisting of the following:

1. Complete distribution for power, lighting, signal, control communications indicated on plans, including switches and circuit breakers, feeders, sub-feeders, grounding under-floor raceways, panelboards, branch circuits, control wiring, switches and receptacles and all other equipment shown on drawings. Provide 5' of spare conductor cable at each end of raceway for termination purposes. Provide all cabling unless noted otherwise. All conductors, bussing, connections and components shall be copper.

2. Connection of all motors, electrically operated equipment and controls furnished under this or any other Division of these Specifications.

3. All conduits, sleeves and backboards, and terminal cabinets required for all systems.

4. Furnishing and installation of all lighting fixtures, lamps, hardware, pole bases, etc.

5. Temporary electrical power and lighting shall be furnished, installed and maintained for all trades. Provide meter for billing allocation. Coordinate with Owner prior to bid as to charge back to Contractor for electric power usage reimbursement to Owner.

6. Painting shall be as specified in other Sections of these Specifications (See "Painting" Section), except that all exposed raceways, fittings, boxes, supports, panelboards, etc., shall be prepared for painting by removing all oil, grease, dirt, etc.

    a. The Contractor shall employ the necessary precautionary methods to prevent painting over or obscuring any and all devices. The painting of panelboards, motor controllers and similar electrical apparatus shall be limited to touching up any surface scratches or marred during shipment or erection. The materials used shall match exactly the surface being touched up.

7. Miscellaneous items obviously required for a complete and operating system, but not specifically called for on the drawings or in the specifications, shall be provided by the Contractor at no extra cost to the Owner (nuts and bolts, masonry anchors, conduit and equipment supports, drilling, welding, scaffolding, crane service, etc.).

8. Required demolition and removal and re-installation of specific existing fixed equipment including but not limited to: (coordinate through Architect/Owner).

PART 2 – PRODUCTS

(Not Applicable To This Section)

PART 3 – EXECUTION

(Not Applicable To This Section)

SEE PAGE 16010-4 FOR "SUBMITTAL IDENTIFICATION SHEET"

END 16010

SUBMITTAL IDENTIFICATION SHEET

PROJECT: _____

CONTRACTOR: _____

SUBCONTRACTOR: _____

SPECIFICATION REFERENCE: _____

ITEM: _____

NO. OF PAGES OF SUBMITTAL: _____

MODEL NO: _____

MANUFACTURER: _____

IS ITEM AS SPECIFIED: _____

REQUEST OF SUBSTITUTION: _____

OPTIONS/ACCESSORIES INCLUDED: _____

DEVIATIONS FROM SPECIFICATIONS: _____

ADDITIONAL REMARKS: _____

ENGINEER'S COMMENTS: _____

CONTRACTOR'S REVIEW STAMP

HANSON PROFESSIONAL SERVICES INC. (HANSON)
SHOP DRAWING, PRODUCT DATA OR SAMPLE REVIEW

☐ No Exceptions Taken
☐ Furnish as Corrected
☐ Revise and Resubmit
☐ Rejected – See Remarks

Hanson's review of submittals is solely for their general conformance with Hanson's design intent and general conformance with information given in the construction documents. Hanson's markings or comments shall not be construed as relieving the Contractor from compliance with the project plans and specifications, nor departure therefrom. Hanson shall not be responsible for any aspects of a submittal that affect or are affected by means, methods, techniques, sequences and operations of construction, or safety precautions and programs incidental thereto, all of which are the Contractor's responsibility. The Contractor shall be responsible for lengths, weights, dimensions, elevations, quantities, etc., and coordination of the work with other trades. The Contractor shall be responsible to review all submittals and approve them in these respects.

By: Date:

PART 1 – GENERAL

1.01 WORK INCLUDES

A. Base Bid:

1. Electrical Contractor to provide:

a. Electrical work shown on the Electrical Drawings and specified herein.

1.02 RELATED WORK

A. Division 1 - Drawings and general provisions of Contract, including but not limited to, General, Special and Supplementary Conditions and other Division-1 Specification Section, apply to the work of this Section.

1. Division 16 - All applicable sections.
2. Division 15 - All applicable sections.

1.03 QUALITY ASSURANCE

A. All work and materials shall be in accordance with the requirements and codes of the State of Florida, and all other applicable bodies having jurisdiction.

B. If, in the opinion of the Contractor, any part of the specification or plans do not comply with the laws, codes and regulations, that matter shall be referred in writing to the attention of the Architect/Engineer for a decision before proceeding with that part of the work. There shall be no changes in the drawings or specifications made without written approval of the Architect/Engineer. Where a discrepancy exists between the drawings and this specification, the more stringent shall apply.

C. Bidders shall visit the site and familiarize themselves with existing conditions and satisfy themselves as to the nature and scope of the work and the difficulties that attend its execution. The submission of a bid will be construed as evidence that such an examination has been made and that the existing conditions have been allowed for in the bid.

D. Before ordering any material or doing any work, examine the Architectural, Civil, Structural, Electrical and Mechanical and Equipment drawings, and verify all conditions of the project. Any differences that occur between drawings or between them and the specifications, or between both of these and actual field measurement shall be reported in writing to the Consultant and written instructions for changes shall be obtained before proceeding with work.

1.04 REFERENCES TO STANDARDS

A. All materials and equipment furnished and installed under this contract shall be in accordance with the latest governing edition of the following applicable technical society, organization or body.

1. UL — Underwriter's Laboratories, Inc.
2. NFPA-70 — National Electrical Code.
3. NFPA-72 — National Fire Alarm Code.
4. NFPA-101 — Life Safety Code.
5. NFPA-110 — Emergency and Standby Power Systems.
6. 4A-3, F.A.C. — The State Fire Prevention Code (1990 edition)
7. Florida Building Code
8. Accessibility Requirements Manual, effective January 1, 1990 (Florida Department of Community Affairs).
9. NEMA - National Electrical Manufacturers Association
10. ASTM - American Society for Testing and Materials
11. IEEE - Institute of Electrical and Electronic Engineers
12. ANSI - American National Standards Institute, Inc.

B. Reference to standards shall mean and intend the latest edition of such standards adopted and published at the date of bidding documents.

C. Materials and installations, as a minimum, shall conform with local and state codes and ordinances. Equipment, where applicable, shall be Underwriter's Laboratories, Inc., listed and shall conform to National Electrical Manufacturer's Association (NEMA) Standards. Do not reduce standards if quality and workmanship established by Drawings and Specifications do not meet or exceed any of these codes and ordinances.

1.05 SUBMITTALS

A. In accordance with Division 1.

1. Product Data

a. Fire Stopping Material
b. Conduit / Raceways
c. Disconnects
d. Fuses
e. Circuit Breakers
f. Conductors
g. Transfer Switch

2. Corrections or comments made on the shop drawings during the review do not relieve this contractor from compliance with requirements of contract documents, plans and specifications. Shop drawings will be checked for general conformance with the design concept of the project and general compliance with information given in the contract documents. Review of the shop drawings shall not relieve the contractor from responsibility for details and accuracy, confirming and correlating all quantities and dimensions, selecting fabrication processes, for techniques of assembly and construction, coordinating his work with that of all other trades, and performing his work in a safe and satisfactory manner. Review of shop drawings shall not permit any deviation from plans and specifications.

3. Contractor shall submit ½" scale drawings showing layouts of each equipment room for Consultant review. Show elevations of panels, controls, etc., for all interior walls at ½" scale.

4. Contractor shall submit point to point wiring diagram for all signal and control systems, control panels, terminal cabinets, etc., for Consultant review.

5. Complete shop drawings shall be submitted as a "package" per each system. (i.e., product data, scale layouts, plans, wiring diagrams, etc).

6. Contractor shall submit conduit/conductor runs for all systems showing intended routings for Consultant review.

7. Shop Drawings shall indicate terminal identification, barrier strip layout.

8. Submit complete shop drawings, per system, as a package.

B. In accordance with Division 1, at the completion of the project, Contractor shall submit operating instructions and maintenance manuals. Submit model number, catalog information, technical data sheets, shop drawings, test reports, wiring diagrams, parts lists and maintenance instructions where applicable for each of the following items of equipment (minimum, but not limited to, equipment and systems).

   The Contractor is specifically cautioned that the Owner is entitled to all operating and instruction manuals, wiring and schematic diagrams, and other technical documentation whereby repairs and maintenance by the Owner or its designated representative may be performed. Unwillingness to comply with this requirement shall be grounds for rejection of the use of that manufacturer.

   1. Wiring Devices
   2. Switchboards
   3. Circuit Breaker and Distribution Panelboards
   4. Motor Starters and Controls
   5. Light Fixtures
   6. Emergency Power Generator System, Transfer Switch, Fuel System and Accessories
   7. Fire Alarm and Detection System

C. Throughout the progress of construction, keep a complete and detailed record of all deviations in the electrical installation from that indicated on the Drawings, specifications and/or shop drawings. At the completion of the project and prior to final payment this marked set of drawings shall be submitted to the Architect/Engineer. As-Builts shall be legible and clearly indicating depths, dimensions of raceways from unknown points. Provide one mylar set of reproducibles and three print sets to the Owner, certified and signed, by the Contractor as to their accuracy.

D. Comply with the following for all work specified in Division 16. As-Built information shall be shown to scale, using standard symbols listed in the legend. As a minimum show the following:

1. Location of stub-outs and dimensions from permanent building lines.
2. Location and depth of under slab and in slab raceways.
3. All routing of raceways, dimensions from building, depths.
4. Corrected panelboard and equipment schedules.
5. Corrected circuit numbers as they appear on panelboard directories.
6. Corrected motor horsepower and full load amperages.
7. Number, size, type of insulation and number of wires in each conduit or multi-conductor cable whether in conduit or exposed.
8. Location of junction boxes and splices.
9. Location of access panels.
10. Conduit/wiring for all communication, signals systems, dimming systems.

1.06 TEMPORARY ELECTRICAL SERVICES

A. In accordance with Division 1.

B. Provide temporary lighting for safety and security throughout the Project.

C. Provide temporary power for construction needs throughout the project. Coordinate through utilities for services.

1.07 GUARANTEE

A. Guarantee all materials and workmanship for a period of one (1) year in accordance with the General Conditions.

1.08 DELIVERY, STORAGE AND HANDLING

A. Materials shall be suitably packaged by manufacturer to prevent damage during shipment. Damaged materials will not be acceptable for use.

B. Store materials on site in clean, dry storage area; when outside, elevated above grade and enclosed with durable watertight wrapping.

C. Handle all materials carefully to prevent damage. Minor scratches, marks or blemishes to finish shall be repaired by Contractor.

PART 2 – PRODUCTS

2.01 MATERIALS

A. General

1. All equipment and material for permanent installation shall be new unless specifically indicated otherwise. In addition material shall:

a. Be without blemish or defect.
b. Not be used for temporary power or lighting without prior written authorization from the Owner.
c. Be in accordance with NEMA Standards.
d. Bear Underwriter's Label where subject to U.L. label service.
e. Be U.L. listed for its intended service and application.

2. Equipment and materials of the same type of classification and used for the same purposes, shall be products of the same manufacturer.

3. Materials and equipment shall conform in all respects to the requirements set forth in these specifications and the accompanying drawings. However, wherever a product is identified by name, equal products which meet the Owners/Consultant's written approval may be used (per contract document procedures). A minimum of 14 calendar days prior approval will be required.

4. Except as otherwise specified, materials and equipment shall be new and bear the approval label of Underwriter's Laboratories, Inc.

5. Where equipment and materials are specified or designated on drawings by trade names and catalog numbers, the intent is to establish a standard of quality, appearance, performance and dimension. Materials and equipment of other manufacturers will be considered, provided they are equal in all respects to that specified. However, it will be the Contractor's responsibility to demonstrate equality of substitution with materials or equipment specified by the Consultant. Substitutions shall require a minimum of 14 calendar days prior approval and be subject to Division 1. Compensations for "as-built" drawings or contract documents requiring additional engineering services due to Contractor substitutions shall be paid directly by the Contractor to the Consultant. The Consultant shall be compensated by the Contractor for multiple reviews (more than two) of any shop drawing submission.

B. Fire Stopping Material

1. Fire stopping materials shall consist of commercially manufactured products capable of passing ASTM E-814 (UL 1479) Standard Method of Fire Test for Through Penetration Fire Stops.

2. Provide fire stopping materials to maintain the rating of the wall, partition or floor opening that penetration is made.

3. Fire stopping materials shall be U.L. classified.

4. Acceptable Products

a. 3M - Fire Barrier
b. Thomas & Betts - Flame Safe
c. Nelson Electric - Flameseal

d. IPC

C. Water Seal

1. Seal penetrations of perimeter walls or floors below grade to prevent entry of water. Use materials compatible with wall or floor construction.

2. Seal penetrations of roof, with flashings compatible with roof design.

D. Nameplates

1. General: Furnish and install nameplates wherever indicated as "required" in these specifications. Wording shall be submitted to the Architect/Engineer for review prior to purchase of nameplates.

2. Material: 1" high black phenolic engraving stock, white core.

3. Lettering: Engraved. Approximately 1/2 inch high for floor mounted equipment and 3/16 inch high for wall mounted equipment. Wording shall identify function of device to which nameplate is attached or identify equipment serviced by device.

4. Provide red labels with white lettering at all flush-plates, switches, outlets, devices, equipment, etc. connected to the emergency or essential electrical systems or services.

PART 3 – EXECUTION

3.01 INSTALLATION

A. All equipment and materials shall be installed and completed in a first-class workmanlike manner. The right is reserved to direct the removal and replacement of any item, which in the opinion of the Owner's Representative and/or Architect/Engineer does not present an orderly and reasonably neat or workmanlike appearance, provided such items can be properly installed in an orderly way by usual methods in such work. The right is also reserved to require the removal of items and/or installations which do not conform to the Contract Documents.

B. Electrical drawings are diagrammatic but shall be followed as closely as actual construction of the building and the work of other trades will permit. Consult Architectural drawings and details for exact location of fixtures and equipment and buildings element dimensions. Because of the small scale of drawings, it is not possible to indicate all of the offsets, fittings and accessories required. This subcontractor shall investigate the structural and finish conditions affecting his work and shall arrange such work accordingly, providing fittings, bends, junction boxes, pull boxes, access panels and accessories required to meet such conditions. Conduit/duct-bank layouts, locations are to be coordinated with all Contractors by the Division 16 Contractor. Locations are approximate and the Division 16 Contractor shall allow for field adjustment. Additional monies will not be approved for field conditions or lack of coordination on the part of the Contractor.

C. No deviations from the plans and specifications shall be made without the full knowledge and consent of the Consultant. Should the Contractor find at any time during the progress of the work that, in his judgment, a modification of the requirements of any particular item is needed; he shall report such item promptly to the Consultant for his decision and instruction.

D. Discrepancies in Electrical and Mechanical Drawings - it is recognized that locations of piping, ductwork, etc., shown on Mechanical and Electrical drawings are diagrammatic, except for figured dimensions, and that field conditions may arise that will prevent their being installed as noted on drawings, such as runs of pipe cross-overs, risers, panelboards, electric outlets, machinery, etc., within limits established by figures on Architectural Drawings. It is the duty of each and every sub-contractors to consult with each other, verifying existing conditions and in each case where there is any question or doubt as to space conditions or location of outlets, etc., to submit a timely workable solution to the Consultant for their approval before installing any work which is questionable.

E. The Contractor is specifically directed to the mechanical section of the contract documents for coordination.

F. The Contractor shall refer to the entire set of contract documents for bidding purposes and completeness of proposal. Items not shown on the electrical project documents, but shown on mechanical requiring wiring, components, raceways, etc., must be included in bid proposal to provide a complete working system. Systems and devices shown on one portion of documents shall be as if they apply to all portions of the contract documents.

G. The Contractor (including electrical subcontractor) shall, prior to rough-ins, confirm all location of device with owner representative and architect. Coordinate with architectural drawings interior elevations for exact locations, mounting heights, dimensions for installation of all items. Coordinate with wall coverings, furniture, etc.

H. Install all equipment in accordance with manufacturer's recommendations.

I. Provide all necessary anchoring devices and supports.

1. Use structural supports suitable for equipment, or as indicated.
2. Check loadings and dimensions of equipment with shop drawings.
3. Do not cut or weld to building structural members.

J. Verify that equipment will fit support layouts indicated.

1. Where substitute equipment is used, revise indicated supports to fit.

K. Arrange for necessary openings to allow for admittance of equipment.

1. Where equipment cannot be installed as structure is being erected, provide and arrange for building-in of boxes, sleeves or other devices to allow later installation.

L. Make all penetrations through roofs prior to installation of roofing. For penetrations required after installation of roofing:

1. In built-up roofing (BUR), provide all curbs, cants and base flashings.
2. In elastic sheet roofing (ESR), arrange and pay for base flashing work by authorized roofer.

M. Install rain hoods and metal counter flashings as indicated and make all penetrations for electrical work through walls and roofs water- and weather-tight.

1. Furnish all clamps, waterproofing material and labor necessary.
2. Where metal flashings are applied over concrete, paint concrete with 1/8 inch of mastic cement first.
3. Set flashing in mastic cement, watertight.

N. Repair and replace roof construction, damaged by this work, in manner which will not nullify roof guarantee.

O. Provide equipment guards at all belts, couplings, moving machinery and equipment provided under this division in accordance with OSHA.

1. Use suitable structural frames with 12 gauge, 3/4" maximum opening galvanized mesh, or expanded metal mesh.
2. Attach to equipment by removable clips and bolts with wing nuts, or other approved connectors.

P. Install equipment to permit easy access for normal maintenance.

1. Maintain easy access to switches, motors, drives, pull boxes, receptacles, etc.
2. Relocate items which interfere with access.

Q. Provide concrete foundations or pads required for electrical equipment, as indicated or as follows:

1. Where drawings do not show special foundations, install 4 inch high concrete pads.
2. Use 3,000 PSI concrete.
3. Reinforce with 6 x 6 x 10 x 10 mesh, with short dowels into floor at 12 inch OC around perimeter.
4. Chamfer top edges 3/4 inch
5. Rub all faces smooth with carborundum block.
6. Set anchor bolts for equipment.

3.02 LOCATION OF EQUIPMENT

A. The approximate location of all equipment and devices is shown on the Drawings. The Owner's Representative and/or Architect/Engineer reserves the right to change the location of all equipment or devices 6 feet in any direction at no additional cost provided such changes are requested before final installation.

B. Install all equipment with ample space allowed for removal and repair meeting manufacturer's recommendations and code requirements. Provide ready accessibility to removable parts of equipment and to all wiring without moving equipment which is installed or which is already in place. Provide access panels for all devices installed above non-accessible ceilings and/or within walls or partitions.

C. In mechanical and electrical equipment spaces, expose ceiling outlets and conduit with due consideration to ventilating ducts and mechanical piping. Where numerous ducts occur, install conduits and outlets after the ventilating ducts. Puncturing of duct work or hanging equipment such as light fixtures, ceiling hangers and conduits from duct work is prohibited. Submit "comprehensive" shop drawings for every mechanical, electrical room, ¼" scale plans, elevations. Contractor is cautioned to include all costs in bid to provide all required electrical systems complete in mechanical spaces. Contractor may locate starters, switches, etc. to coordinate with field construction, but must maintain clearances, performance, and accessibilities.

D. Electrical equipment shall be installed to maintain minimum clearances per Article 110 of the NEC and ANSI C2 (National Electrical Safety Code and recommendations of manufacturer/vendor).

E. Dimensions indicated on documents are limiting dimensions. Do not provide equipment exceeding dimensions indicated or equipment/arrangements that reduce required clearances or exceed specified maximum dimensions.

3.03 COORDINATION

A. Provide day-to-day coordination with the work of other contractors engaged in this project. Execute the work in a manner not to interfere with other contractors.

B. Coordinate with other contractors regarding the location and size of pipes, raceways, ducts, openings, and devices, so that there may be no interferences between installations or the progress of any contractor.

C. If conflict arises in the installation of work, the following preference schedules shall be followed:

1. Recessed lighting fixtures.
2. Sanitary drainage.
3. Steam condensate, hot and chilled water piping.
4. Low pressure ductwork.
5. Domestic water, storm and vent lines.
6. Electrical conduits.

D. This Contractor shall notify all other contractors of any deviations or special conditions necessary for the installation of his work. Interferences between the work of various contractors shall be resolved prior to installation. Work installed not in compliance with the plans and specifications and without properly checking and coordinating as specified above shall, if necessary, be removed and properly reinstalled by this Contractor without additional cost to the Owner. The Consultant or his representative shall be the mediating authority in all deviation and confliction disputes arising on the project.

E. Insofar as it is possible to determine in advance, this Contractor shall consult with the masonry contractor and others as to leaving the proper chases and openings for his work; and he shall place all of his outlets, anchors, sleeves and supports prior to pouring concrete or masonry work. Should this Contractor neglect doing this, any cutting and/or patching shall be done at this Contractor's expense.

F. Contractor must notify Owner prior to excavation and exercise due caution with regard to disturbance of utilities and services.

G. Contractor shall be held responsible for any damage and restoration to utilities and services. Restoration shall be made expeditiously with methods and materials that are approved for the intended use. Provide written report to the Owner detailing occurrence and corrective action.

H. Where indicated on the drawings, the locations of existing underground utilities are shown in an approximate way only and have not been independently verified by the Owner or its representative. The Contractor shall determine the exact location of all existing utilities before commencing work and agrees to be fully responsible for any and all damage which might be occasioned by the Contractor's failure to exactly locate and preserve any and all utilities.

I. Contractor must provide exit luminaries and fire alarm horn/strobes so they are visible from all corridor locations.

J. Contractor shall provide proposed solution for field request coordination concerns for architect review. Requests for information and resolution shall be submitted so as to not delay projects and provide architect 5 days minimum review time, or as specified in Division 1.

3.04 WALL, ROOF AND FLOOR PENETRATIONS AND SLEEVE INSTALLATION

A. Provide sleeves for all electrical raceways, and wiring passing through walls and floors and roof. Sleeves shall be of sufficient length to extend through the wall, roof and floors. Wall sleeves shall have ends flush with finished thickness of walls and floor sleeves shall extend 1 inch above finish floor. Interior diameter of sleeves shall provide 1/2 inch clearance all around conduit.

B. Set all wall, roof and floor sleeves during the construction of same in new construction.

1. Structural concrete beams shall be sleeved only in the middle 1/3 of span. Notify Architect/Engineer of any required deviation from this prior to placement of sleeve.

C. Below grade wall and roof penetration shall be made watertight. Below grade wall penetration shall be sealed with compression type conduit sealing bushings. Roof penetration shall be sealed and flashed per roof manufacturers published recommendations.

D. Where cutting is required to facilitate construction, this contractor shall patch and repair cut items to the original state. However, structural work shall not be cut without the written approval of the Architect/Engineer or his representative.

E. Holes through concrete and masonry in new and existing structures shall be cut with a diamond core drill or concrete saw. Pneumatic hammer impact, electric hand or manual hammer type drills, shall not be allowed, except where permitted by the resident engineer or as required by limited working space.

F. Cutting and Patching

1. Any routing damage caused by cutting or in any other way caused by this Electrical Contractor in the performance of his contract shall be repaired or replaced under the separate heading for the type material included in a manner satisfactory to the Architect.

2. Any unnecessary damage caused by this Contractor, due to installation of the electrical work, brought about through carelessness or lack of coordination, shall be corrected under the separate heading for the type of materials involved, but paid for by his Contractor.

G. Access Panels

1. The Contractor's attention is called to access panels. It is a requirement of these specifications that all access panels required in architectural finishes or surfaces to provide access to junction boxes, smoke detectors, strip heaters, ballasts or other devices be provided and located by the trade constructing the base or frame to which the access panel will be anchored. Advise Consultant of locations, size of all panels. Coordinate utilities to minimize openings.

3.05 FIRESTOPPING

A. Where conduits, wireway, bus duct and other electrical raceways pass through fire partitions, fire walls or walls and floors, install a firestop that provides an effective barrier against the spread of fire, smoke and gases. Fire-stop material shall be packed tight, and completely fill clearances between raceways and openings. Fire-stop material shall conform to the following:

1. Fire-stopping material shall maintain its dimension and integrity while preventing the passage of flame, smoke and gases under conditions of installation and use

when exposed to the ASTM #119 time-temperature curve for a time period equivalent to the rating of the assembly penetrated. Cotton waste shall not ignite when placed in contact with the non-fire side during the test. Fire-stopping material shall be non-combustible as defined by ASTM E136, and, in addition, for insulation materials, the melting point shall be a minimum of 1700° F for 2-hour protection.

2. Unused, spare sleeves in electrical closets shall be sealed with threaded steel caps on each end.

B. Fire stopping materials shall be installed in accordance with manufacturers written instructions.

3.06 PROTECTION OF WORK

A. Protect work from mechanical damage by keeping all conduit and boxes capped and plugged or otherwise protected. This includes damage by freezing and/or stoppage from building materials, sand, dirt, or concrete.

B. Protect all equipment and fixtures from damages during the project, provide all tarpaulins, drop cloths, barricades, temporary heaters or auxiliary equipment.

C. All materials or equipment damaged during construction shall be repaired or replaced with new items to the satisfaction of the Architect/Engineer/Owner. Replacement shall be accomplished so as to not delay project schedules.

3.07 IDENTIFICATION

A. Furnish and install approved permanent nameplates on all items of electrical equipment showing nature and function of each piece of equipment. This shall include switchboards, motor control centers, panels, motor starters, disconnect switches and motor control devices. Nameplates shall be fastened to devices (except for factory-installed nameplates) with sheet metal screws after finish painting of item has been completed.

B. Identify above ceiling junction box covers with legible designation as to service, circuit numbers and/or system. This shall be done with permanent ink marker or method described elsewhere herein. Identify all other screw covered boxes, junction boxes, terminal cabinets with permanent engraved nameplates.

C. Identify every conductor with "Brady Tags" or approved equivalent for maintenance, trouble shooting purposes. Identify at terminations and pull-boxes, splice boxes, terminal cabinets, accessible areas.

D. Tag all conductors and identify major conduits in or at wireway, panels, pull boxes, switchboards, motor controllers, cabinets and similar items to assist in future circuit tracing. Conductor tags shall be non-conductive.

E. Identify all circuits and equipment to correspond with the plans and specifications.

F. Use phenolic nameplates for panelboards, switchboards, disconnects, etc., or other approved methods except as indicated otherwise. Provide nameplate for manual transfer switch indicating the voltage, phase, type (Wye or Delta), and rotation.

G. All junction boxes shall have type of system and voltage of contained conductors stenciled on inside, outside of box cover.

3.08 PAINTING

A. Finish painting shall be as specified in Division 9.

B. Provide touch-up painting of all electrical equipment marred in any way during shipment or installation.

3.09 CONNECTIONS TO EQUIPMENT

A. Equipment: The Contractor shall make final electrical connections to all items of equipment. All power wiring from power source through starters, disconnects and control panels to equipment shall be provided.

3.10 SAMPLES

A. Physical samples of material and equipment proposed for installation in this project shall be submitted to Consultant upon request.

B. Samples shall be submitted through the General Contractor with all shipping and handling charges prepaid. Any expense incurred in securing, delivery and return of samples, is the responsibility of Contractor. Samples shall be delivered to location designated by Consultant.

C. Samples shall remain the possession of the Contractor except as follow:

1. Approved samples, without physical damage, may be installed on the project.
2. Samples not called for within 14 calendar days after notification will be disposed of by the Consultant.

3.11 SPARE PARTS AND TOOLS

A. Furnish to Owner and obtain receipt for same, the following:

1. One set of fuses for each size and type installed on project.
2. One set of special tools required for equipment furnished, spare keys, etc.
3. One spare smoke detector, heat detector, manual pull station, horn, strobe, and duct detector.
4. One set of overloads or heaters for each size and type motor starter installed on project.

3.12 FINAL INSPECTION AND TESTS

A. As precedent to final inspection and acceptance, the Contractor shall have all previously listed defects corrected, complete all work, test all systems and have data on such tests, have all directories, labels and instructions posted, complied with applicable paragraphs of this section.

3.13 PERFORMANCE

A. The Contractor shall employ a competent foreman on the job throughout the entire period of construction to see that his work will not conflict with other trades and that it is properly performed.

B. The foreman shall have a thorough knowledge of the work to be installed under this contract, be a skilled mechanic experienced with projects of equal size and type. Foreman shall have valid County Journeyman license.

END 16050

PART 1 - GENERAL

1.01 WORK INCLUDES

A. Base Bid:

1. Electrical Contractor to provide:

a. Feeders and branch circuit conduits for power and lighting systems, and for conductors of all other electrical systems. Install conduit complete with outlet boxes, junction or pull boxes, and fittings, shown on the drawings or herein specified.
b. Wireways with related fittings.
c. Surface metal multi-outlet raceway.

2. Temperature Control Contractor to provide:

a. Temperature control raceways.

3. General Contractor to provide:

a. Painting of exposed raceways.
b. Flashing and sealing of all raceway roof penetrations.

1.02 RELATED WORK

A. Specified Elsewhere:

1. Drawings and general provisions of Contract, including, but not limited to, General, Special, and Supplementary Conditions and other Division-1 Specification Sections, apply to the work of this Section.
2. Division 15 - applicable sections.
3. Division 16 - applicable sections.

1.03 QUALITY ASSURANCE

A. Provide all new materials, without blemish or defect, in accordance with standards specified and UL listed or labeled.

1.04 SUBMITTALS

A. Submit in accordance with Division 1.

B. Product Data:

1. Conduit and fittings.
2. Wireway and related fittings.
3. Surface metal raceways.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Rigid steel conduit shall be sherardized or hot dipped galvanized steel pipe, bearing U.L. label and conforming to ANSI Publication C80-1.

1. Acceptable Manufacturers:

a. Cal Conduit Products
b. Wheatland Tube Company
c. Republic Conduit
d. Allied Tube & Conduit Corporation

B. Couplings, connectors and fittings for rigid steel conduit shall be threaded galvanized steel or galvanized malleable iron specifically designed and manufactured for the purpose. Fittings shall conform to ANSI C80.4.

C. Electrical metallic tubing (EMT) shall be U.L. listed and shall conform to ANSI Publication C80-3. Conduit shall be thoroughly protected from corrosion by electro-galvanizing.

1. Acceptable Manufacturers:

a. Allied Tube & Conduit Corporation
b. Republic Conduit
c. Wheatland Tube Company
d. Cal Conduit Products

D. EMT fittings shall be of the steel compression type, rain and concrete tight, with steel compression nuts. Connectors shall be insulated throat with case hardened locknuts. Fittings shall conform to ANSI C80.4

1. Acceptable Manufacturers:

a. Appleton
b. Raco
c. Thomas and Betts
d. Efcor

E. IMC conduit shall be threaded zinc coated steel tubing specified for Intermediate Metal Conduit (IMC) and shall conform to Underwriters' Laboratories, Incorporated Standard UL 1242. Do not use unless specifically noted on documents.

1. Acceptable Manufacturers:

a. Allied Tube & Conduit Corporation
b. ETP
c. Wheatland Tube Company

F. Aluminum conduit shall not be used unless specifically noted on the documents.

G. Flexible conduit shall be hot dipped galvanized steel or aluminum flexible conduit. In areas where such connections will be exposed to grease, oil, water or weather, flexible liquid tight conduit shall be used. Comply with UL-1, and UL-360.

1. Acceptable Manufacturers:

a. Anaconda
b. Electri-Flex
c. Wheatland Tube Company
d. International Metal Hose.

H. Connectors shall be compatible with flexible conduit used and shall be UL listed for grounding means.

1. Acceptable Manufacturers:

a. Midwest
b. Raco
c. Thomas and Betts
d. Appleton
e. O - Z Gedney
f. Efcor

I. Plastic conduit shall be PVC Type EPC-40 Heavy wall rated for 90 deg. C cable meeting NEMA Standard TC-2, and UL listed for concrete encasement. Nonmetallic conduit fittings and conduit bodies comply with NEMA TC-3.

1. Acceptable Manufacturers:

a. Carlon Products Company
b. Robintech
c. Can-Tex

J. Wireways: Provide electrical wireways of types, and sizes as indicated. Provide complete assembly or raceway including, but not limited to, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, ceiling hangers, and other components and accessories as required for complete system.

1. Lay-In Type: Provide lay-in wireways with hinged covers, in accordance with UL 870 and with components UL listed, including lengths, connectors, and fittings. Select units to allow fastening hinged cover closed without use of parts other than standard lengths, fittings and connectors.

2. Connectors: Provide wireway connectors suitable for "lay-in" conductors, with connector covers permanently attached so that removal is not necessary to utilize the lay-in feature.

3. Finish: Protect sheet metal parts with rust inhibiting coating and baked enamel finish. Plate finish hardware to prevent corrosion. Protect screws installed toward inside of wireway with spring nuts to prevent wire insulation damage.

4. Acceptable Manufacturer's:

   a. Square D
   b. Hoffman
   c. Wiegmann
   d. Walker

K. Surface Metal Multi-Outlet Raceway: Multi-outlet assembly for prewired outlets, lengths as indicated. Provide 4-wire, two circuit grounding with outlets on 18" centers. Provide 15 ampere, 125 volt outlets, NEMA Type 5-15R. Raceway shall be prime coated for field painting. Outlets shall be ivory color.

1. Acceptable Products:

   a. Wiremold - Plugmold 2000
   b. Walker - Walkermold 2GW Series

L. Multi outlet two piece surface metal raceway systems shall consist of steel raceway components with factory applied gray finish. Provide center divider strip for separation between power and communications. The system is to be furnished with receptacles at spacing shown on the drawings. Raceway shall be UL listed. Furnish with all standard accessories for a complete installation.

1. Acceptable Products:

   a. Wiremold G-4000
   b. Walker 3400

M. Grounding Bushings: With screw termination for green bond wire.

1. Provide per NEC, all areas

PART 3 - EXECUTION

3.01 INSTALLATION

A. Conduit Schedule

1. Minimum conduit size shall be 3/4 inch unless otherwise specified.

B. Conduit shall be installed in accordance with the following:

1. All conduits in or below floor slabs shall be RGS or PVC and in masonry and concrete walls shall be rigid steel. All rigid steel conduit routed underground or

in the concrete slab shall be painted with two coats of bitumastic compound. Provide RGS "EL"s in all raceways stubbing through slabs.

2. All branch circuit conduits in stud partitions and drop ceiling areas, and exposed 4 feet above finish floor may be EMT (thinwall) conduit.

3. All exposed motor, heater branch circuit conduits shall be rigid steel. EMT conduit may be used provided the conduit is adequately protected and it is not installed in the slab or underground.

4. Conduit systems for telephone, fire alarm, and miscellaneous systems shall consist of EMT (thinwall) conduit in drop ceilings, and stud wall partitions and exposed 4 feet above finish floor. All other conduit shall be rigid steel.

5. PVC conduit may be utilized for underground applications, subject to limitations as specifically noted on drawings or within specifications.

6. Flexible conduits shall be used as herein specified.

7. Rigid aluminum conduit, IMC may be used only if specifically noted. Do not use underground or embedded in concrete.

8. Provide metallic raceways, conduits only for sound, theatrical lighting systems, dimming systems, and fire alarm systems.

C. Conduit Runs

1. All conduits shall be sized as indicated on the Drawings, or for conduit sizes not shown shall be in accordance with the National Electrical Code. All conduit systems shall be mechanically and electrically continuous from source of current to all outlets and grounded in accordance with the National Electrical Code.

2. Conceal conduit wherever possible, or expose as shown or noted on the drawings and as specified hereinafter. Run all exposed conduit parallel to building walls using right angle bends. Exposed diagonal runs of conduit will not be permitted. Do not install conduit on roof surfaces unless specifically indicated on the Drawings. Contractor shall run all raceways concealed within walls in all finish areas.

3. Any conduit installed in concrete slabs shall be located such that it will not adversely affect the structural strength of the slab. Install conduit within the middle one-third of the slab. The outside diameter of any conduit run in concrete slabs shall not exceed one-third of the thickness of the slab. Where embedded conduits cross expansion joints, provide suitable watertight expansion fittings and bonding jumpers. Conduit larger than one inch trade size shall be parallel with or at right angles to the main reinforcement; when at right angles to the reinforcement, the conduit shall be close to one of the supports of the slab. Space conduit horizontally not closer than three

diameters, except at stub-up locations. Do not stack. Curved portions of bends shall not be visible above the finish slab.

4. Encase primary, secondary service entrance and telephone conduits in 3 inch concrete envelope coverage, 2" concrete between raceways.

5. Install conduit at least 12 inches from gas, steam or hot water piping parallel runs, at least 6 inches in cross runs and at least 3 inches from cold water piping.

6. Ream conduit after threads are cut. Cut ends square, and butt solidly into couplings.

7. Prevent the accumulation of water, foreign matter or concrete in the conduits during the execution of the work. Temporarily plug conduit, blowout and swab before wires are pulled. Seal all below grade raceways terminating in a handhole, etc.

8. Where insulated bushings are used, fasten conduits to all sheet metal boxes and cabinets with two locknuts in accordance with NEC.

9. Provide conduit expansion joints at building expansion joints for conduit runs 1-1/2 inches and larger. Provide conduit expansion joints or flexible conduit connection at building expansion joints for conduits less than 1-1/2 inches.

10. Seal each underground joint and make watertight.

11. Where building construction or other conditions make it impossible to use standard threaded couplings, install watertight threaded unions.

12. Make changes in direction of runs with symmetrical bends or cast-metal fittings. Make field-made bends and offsets with conduit bending machine to avoid changing the internal diameter of the conduit and not damage its protective coating either inside or outside. Individual bends shall not exceed 90 degrees and not more than 270 degrees total bends will be allowed in any one conduit run. Where more bends are necessary, and conduit runs exceed 150 lineal feet, install a suitable pull box or junction box.

13. Provide empty conduits installed with a pull wire. Pull wire shall be No. 14 AWG zinc-coated steel, or of plastic having not less than 200 pound tensile strength. Leave not less than 12 inches of slack at each end of the pull wire.

14. Use liquid tight flexible conduit for final connection to motors, portable equipment and for equipment subject to vibration and noise transmission. For each conduit size up to 1 inch trade size, flexible conduit shall be minimum length of 12 inches and a maximum length of 36 inches. For conduit sizes above 1 inch trade size, flexible conduit shall be minimum length of 20 inches and maximum length of 48 inches.

15. Use flexible metal conduit to connect fixtures to adjacent junction boxes where not an integral part of the fixture. Flexible conduit shall be a minimum 1/2 inch trade size, minimum 4 feet long and maximum 6 feet long nominal. Support all flexible metal raceway with approved clips.

D. Wireway Routing

1. Install continuous as indicated.

2. Install level and parallel to building services.

3. Changes in direction and elevation to be accomplished with factory furnished offsets and corners.

4. Layout, assemble on job, and coordinate wireway system with work of other crafts to avoid conflicts.

E. Raceway Support and Hangers

1. Securely fasten raceways in place and support from ceiling or walls at spacing not exceeding:

Material	Maximum Spacing of Supports
a. 1/2" thru 1" trade size conduit	6 feet
b. 1-1/4" thru 1-1/2" trade size conduit	8 feet
c. 2" to 4" trade size conduit	10 feet
d. Flexible Metal Conduit	4-1/2 feet
e. Wireways	5 feet
f. Cable Tray	10 feet

2. Support rigid, IMC or EMT conduits within 3 feet of every outlet box, junction box, pull box, cabinet or termination. Support flexible conduit within 12 inches on each side of every outlet box or fitting.

3. Support vertical runs of conduits at each floor level and at intervals not to exceed 10 feet.

4. Support conduits by pipe straps, wall brackets, hangers, or ceiling trapeze. The use of perforated iron or wire for supporting conduits is prohibited. Fasten with wood screws or screw nails to wood; by toggle bolts on hollow masonry units, by concrete inserts, or expansion bolts on concrete or spring-tension or threaded C-clamps for rigid steel conduits on steel. Do not weld conduits or pipe straps to steel structures unless specifically indicated.

5. Fasteners attached to concrete shall be vibration and shock resistant.

6. Use caddy-clips or approved listed supports for box, raceways support within stud walls. The load applied to fasteners shall not exceed one-third the proof test load of the fasteners.

7. In suspended-ceiling construction, spring steel fasteners to ceiling supports may be used for the support of flexible raceway serving lighting branch circuit conduits. No other conduits may be supported from the ceiling suspension system.

8. Where two or more conduits one inch trade size or larger run parallel, trapeze hangers may be used, spaced to match smallest conduit consisting of threaded solid rods, washers, nuts and galvanized "L" angle or channel iron. Individually fasten conduits to the cross member of every other trapeze hanger with one hole straps or clamp backs with proper size bolts, washers and nuts. When adjustable trapeze hangers are used, use U-bolt type clamps at end of conduit runs, at each elbow and at each third intermediate hanger to fasten each conduit.

9. Make hangers of durable materials suitable for the application involved. Applied loads shall not exceed one-third of their loading capacity.

10. Fabricate all screws, bolts, washers and miscellaneous hardware used for conduit supports from rust-resisting metal. Trapeze hangers shall have hanger assemblies protected with galvanized finish.

3.02 SPECIAL INSTALLATION

A. Hazardous Locations

1. Perform all work in hazardous locations as defined by the NEC in strict accordance with the NEC for the particular "Class", "Division", and "Group" of hazardous locations involved or indicated on the drawings. Provide conduit and cable seals in accordance with the NEC.

B. Telephone, Data Systems

1. Provide a 1"C. stub with insulated bushings on each end from each outlet to a location above an accessible ceiling for cable runs to the terminal board.

2. Provide screw covered box a minimum of every 100 LF or 180° total bends, size 12x12x6, minimum, where complete conduit runs are required or otherwise necessary.

3. Where applicable, provide bend radius minimum 6x conduit diameter for 2" and less, 10x conduit diameter 2½" and greater.

END 16110

PART 1 - GENERAL

1.01 WORK INCLUDES

A. Base Bid:

1. Electrical Contractor to provide:

a. Wires and cables including splices, connections and supports for a complete installation as shown on the drawings and specified.

2. Temperature Control Contractor to provide:

a. Wiring for all temperature control work.

1.02 RELATED WORK

A. Specified Elsewhere:

1. Drawings and general provisions of Contract, including, but not limited to General, Special, and Supplementary Conditions and other Division-1 Specification Sections, apply to the work of this Section.
2. Division 15 - applicable sections
3. Division 16 - applicable sections

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Wire, cable and installation thereof shall be in accordance with the National Electrical Code.
2. All materials shall be new, without blemish or defect, in accordance with standards specified and UL listed or labeled.

1.04 REFERENCES

A. ICEA S-61-402/NEMA WC-5 Thermoplastic Insulated Wire and Cable

B. ICEA S-66-524/NEMA WC-7 - Cross-Linked Thermosetting Polyethylene - Insulated Wire and Cable.

C. NEMA WC-41 - Coaxial Communication Cable.

1.05 SUBMITTALS

A. In accordance with Division 1.

B. Provide product data for all components.

1. Building wire.
2. Communications, controls wire.

1.06 DELIVERY, STORAGE AND HANDLING

A. Materials shall be suitably packaged by manufacturer to prevent damage during shipment. Damaged materials will not be acceptable for use.

B. Store materials on site in clean, dry storage area.

C. Handle all materials carefully to preclude damage. Material with damaged insulation shall not be acceptable for use.

PART 2 - PRODUCTS

2.01 BUILDING WIRE

A. All wire and cable shall be annealed, coated copper per ASTM B 33 or B 189 with conductivity of not less than 98 percent. All wire shall be stranded, Class B per ASTM B8.

B. All wire shall have 600 volt insulation, UL listed and complying with UL 83, ICEA S-61-402 or ICEA S-66-524 for respective insulation type.

C. Service entrance, feeders and branch circuits larger than No. 6 AWG: 600 volt insulation Type XHHW or THWN.

D. Feeders and branch circuits No. 6 AWG and smaller: 600 volt insulation Type THHN or THWN, unless otherwise noted.

E. Control circuits: 600 volt insulation, THWN.

F. Color code conductor insulation for No. 8 AWG or smaller. Provide color marking tape for No. 6 AWG and larger. Standard colors for power wiring and branch circuit:

208Y/120 V	3 Phase		
Phase A	Black		
Phase B	Red		
Phase C	Blue		
Neutral	White		
Ground	Green		

G. Acceptable Manufacturers:

1. Anaconda Wire & Cable Co.
2. Arthur J. Hurley Company
3. General Cable Corp.

4. Phelps Dodge Wire & Cable Company
5. American Insulated Wire Corporation
6. Southwire Company
7. Okonite Wire & Cable Company
8. Pirelli Cable Corporation

2.02 JOINTS & SPLICES

A. Make terminations, taps and splices with an indent type pressure connector with insulating cover for No. 8 AWG and smaller.

1. Acceptable Manufacturers:

a. Buchanan
b. Burndy Corp.
c. Thomas & Betts
d. Ideal Industries

B. In lieu of indent type connectors insulated spring compression connectors may be used for No. 10 AWG and smaller.

1. Acceptable Products:

a. Buchanan, B-Cap
b. Ideal, Wing Nut
c. ITT Holub, Free Spring
d. 3M, Scotchlok
e. Thomas & Betts

C. Use mechanical compression or bolted type connector for No. 6 AWG or larger. Cover connector with insulating tape or heat shrinkable insulation equivalent to 150% conductor insulation.

1. Acceptable Manufacturers:

a. AMP, Inc.
b. Burndy Corp.
c. General Electric Co.
d. Ideal Industries
e. ITT Weaver
f. 3M Co.
g. O.Z. Gedney Co.
h. Thomas & Betts
i. Anderson
j. Blackburn

PART 3 - EXECUTION

3.01 BASIC WIRING

A. Minimum wire sizes shall in no case be less than shown on the drawings and/or specified herein:

1. Power and lighting branch circuits:

a. Where the farthest outlet of a single branch circuit is less than 75 feet from the panelboard, use No. 12 AWG wire between all outlets and for the home run of that circuit.

b. Where the farthest outlet of a circuit is more than 75 feet from the panelboard, use No. 10 AWG wire for the home run of that circuit and No. 12 AWG wire between all other outlets on that circuit except where larger sizes are indicated.

2. 120 Volt Control and Signal Wiring: No. 14 AWG.

3. Low Voltage Control Wiring: No. 16 AWG.

B. Where conductors are adjusted in size to compensate for voltage drop, equipment grounding conductors shall be adjusted proportionately. Provide a separate equipment grounding conductor in every raceway, metallic or non-metallic. Bond at every box, pull point.

C. Splice only in accessible junction or outlet boxes.

D. Neatly train and lace wiring inside boxes, equipment and panelboards.

E. Make conductor lengths for parallel circuits equal.

F. Maintain color coding of conductors for all systems.

3.02 CONNECTIONS AND TERMINATIONS

A. Identify each conductor in panelboards, junction or pull boxes, or troughs with a permanent pressure sensitive label with suitable numbers or letters for easy recognition. Identify control wiring at each end and in junction boxes with numeric wire number corresponding to control wiring diagram.

B. Thoroughly clean wire before installing lugs and connectors.

C. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.

D. Terminate spare conductors with electrical tape and roll up in box.

3.03 FIELD QUALITY CONTROL

A. Inspect wiring for physical damage and proper connection.

B. Torque conductor terminations to manufacturer's recommended values.

C. Perform continuity tests on all power and branch circuit conductors. Verify proper phasing. Refer to Section 16950 for specific testing requirements.

END 16120

PART 1 - GENERAL

1.01 WORK INCLUDES

A. Base Bid:

1. Electrical Contractor to provide:

a. Outlet boxes, pull and junction boxes, back boxes, and covers and fittings as specified below to complete the raceway systems.

2. Temperature Control Contractor to provide:

a. All boxes required for Temperature Control wiring.

1.02 RELATED REQUIREMENTS

A. Specified Elsewhere:

1. Drawings and general provisions of Contract, including, but not limited to, General, Special, and Supplementary Conditions and other Division - 1 Specification Sections, apply to the work of this Section.
2. Division 15 - applicable sections
3. Division 16 - applicable sections

1.03 SUBMITTALS

A. In accordance with Division 1.

1. Product Data: All boxes.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Outlet Boxes

1. Outlet boxes shall be galvanized or sherardized pressed steel conforming to UL Standard No. 514 and shall meet or exceed the National Electrical Code for size and material.

2. Round boxes and handy boxes shall not be used.

3. All boxes furnished shall be the type designed for the purpose served and listed for the intended application.

4. All switch and receptacle boxes shall be minimum 4 inch square for up to two devices, or solid ganged boxes for over two devices. Boxes shall be complete with minimum 3/4 inch deep tile ring for glazed tile, concrete block or concrete

walls and minimum 3/4 inch deep square ring and covers, for plaster, gypsum dry wall or wood paneled finished walls; covered with 1/2 inch raised galvanized device covers for exposed conduit work.

5. Outlet boxes on exposed conduit systems shall be threaded-hub, cast-metal, conduit type fitting FS or FD suitable for wiring devices installed.

6. Outlet boxes for surface mounted ceiling fixtures shall be minimum 4 inch octagonal or square, minimum 1-1/2 inch deep with lathers channel attached to building construction for suspended ceilings; deep concrete boxes for poured concrete ceiling construction; be installed with 3/4" minimum depth plaster rings on suspended ceilings; four inch octagonal of square with fixture extension pan or deep fixture canopy to enclose the box for exposed conduit work.

7. All outlet boxes for recessed fixtures in accessible ceilings shall be minimum 4 inch square or octagonal, minimum 1-1/2 inch deep installed above fixture opening with flexible conduit connection to fixture.

8. Provide proper mud-rings. No "goof rings" will be acceptable.

9. No aluminum boxes will be accepted, unless specifically noted.

10. Acceptable Manufacturers:

    a. Appleton
    b. Crouse Hinds
    c. Killark
    d. Raco
    e. Steel City

B. Pull and Junction Boxes

1. Pull and junction boxes shall conform to UL Standard No. 50 and be sized in accordance with the National Electrical Code or as indicated on the drawings.

2. Boxes shall be made of code gauge galvanized steel or hot dip galvanized sheet steel. Covers shall be of same gauge of box and be secured to holes with rough head silicon bronze screws spaced at 12 inch centers maximum.

3. Boxes mounted flush in walls shall have cover oversized two inches on all sides and shall be minimum 14 gauge steel.

C. Floor Boxes

1. Cast iron, rectangular, single-gang or two-gang, rain-tight, concrete tight, adjustable floor boxes as indicated, threaded conduit entrance ends, vertical adjusting rings, gaskets, brass floor plates with flush screw-on covers, ground flange and stainless steel cover screws, green enamel finish.

2. Provide duplex receptacle or communication outlet as indicated.

3. Acceptable Manufacturers

   a. Harvey-Hubbell
   b. Midland-Ross
   c. Raco
   d. Steel City

D. Cabinet Enclosures

1. Hoffman
2. ASCO

PART 3 - EXECUTION

3.01 INSTALLATION

A. Locate all ceiling outlets with due consideration to clearance from ventilating ducts and piping.

B. The location of outlets shown on the drawings is diagrammatic only. Coordinate the exact location of outlets with architectural details, equipment connection requirements and work of other contractors. Architect/Engineer or Owner, Using Agency's representative may alter the location of outlets shown within a 6 foot radius prior to installation at no additional costs to project.

C. Protect all outlet boxes from entry of foreign materials.

D. Independently support all boxes from structure and independent of conduits. Electrical conduits shall not be used as sole supports.

E. Suitable pull boxes shall be installed in convenient intermediate locations in all conduit runs in excess of 150 linear feet and runs requiring more than three 90 degree bends.

F. Plug all unused openings. Use threaded plugs for cast boxes and snap in metal plugs for sheet metal boxes.

G. Common boxes used for gang installation with switches and receptacles and low voltage devices shall include barriers between the devices and the switches or receptacles.

H. Provide permanent barriers in common boxes to limit voltage between adjacent switches to 300 volts or less.

I. Outlet boxes serving pendant mounted fixtures installed in structural slabs shall be installed in bottom of rib section of structural assembly unless otherwise indicated.

J. The height of outlets and devices is indicated on the drawings or obtainable from the Architect/Engineer. Use the following as a guide for mounting of outlet boxes, unless otherwise indicated on drawings.

DEVICE	HEIGHT ABOVE FINISHED FLOOR TO TOP OF BOX (U.O.N.)
Receptacles	
Office and Corridors	18"
Above Counters	36" (or 6" above backsplash)
Unfinished Areas	48"
Exterior at Grade	24" (above fin. grade)
Switches	48"
Data Outlets	18"
Telephone Outlets	
Wall	54"
Desk (Wall)	18"
Public	See Arch. Elevations
Fire Alarm Break Glass Stations	48"
Fire Alarm Horns/Lights	80" (per ADA)
Clock Outlets	86"

K. Coordinate height of outlets with Drawings and equipment installations drawings and properly locate height of all outlets. Confirm all heights through Architect prior to rough-in and comply with barrier free accessibility/ADA Standards.

L. Outlet Boxes

1. Stagger outlet boxes; do not use back-to-back boxes, minimum of 12". Stuff the area between each box with fire-rated safing insulation to minimize noise and maintain wall rating.

2. For life safety and emergency systems, spray paint inside of boxes and exposed raceways 6 inches beyond outlet with non-flammable paint.

   All boxes and enclosures for essential circuits shall be marked so as to be readily identified as part of the essential system. Conduit and boxes, including back boxes, panel boards, etc., shall be spot painted. Conduit shall be identified to within 6 inches of the box or enclosure. The following color codes shall be used unless otherwise required to match existing color coding.

   Red Fire Alarm System, Emergency, Life Safety

END 16130

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract - Bidding and Contract Requirements including, but not necessarily limited to, General and Supplementary Conditions and Division 1 - Specification Sections shall govern the work under this section.

1.02 WORK INCLUDED

A. Provide all labor, materials, necessary equipment and services to complete the terminal cabinets work as indicated on the drawings, as specified herein, or both, except for items specifically indicated as "NIC ITEMS". Verify with system vendor minimum cabinet sizes and include costs in bid.

1.03 RELATED WORK

A. Division 16 - All Applicable Sections

B. Division 15 - All Applicable Sections

1.04 SUBMITTALS

A. Submit shop drawings and product data in accordance with Division 1, Division 16

B. Submit schedule for each terminal cabinet indicating the system name, function and service of each wire attached to the terminal blocks. Submit size, descriptive data for each cabinet.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENT

A. Furnish and install cabinets with terminal blocks for the splicing of cable for the various wiring systems as shown on the contract drawings. Cabinets shall be UL listed and match standard panelboards in appearance and dimension.

1. Basis for Design - Square D telephone/equipment cabinets.

2.02 ACCEPTABLE MANUFACTURERS AND MATERIALS

A. Terminal cabinets for clocks, intercom, television, fire alarm, security and all other signal systems, shall be fabricated from unpainted, galvanized, 14 gauge steel, having multiple knockouts, with lapped and riveted or welded corner construction. Cabinets shall be of sufficient size to provide a minimum space of six inches between terminal blocks and four inches on gutter space at sides, as noted on the terminal cabinet detail, but shall not be less than system vendor's minimum recommended requirements.

B. Trims shall be fabricated from code gauge galvanized sheet steel.

C. Trims shall be fastened to cabinets by means of machine screws with captive nuts or clamps and shall be self-supporting on the cabinet trim after trim holding screws have been removed. Trim for flush cabinets shall overlap their respective box by at least 3/4 inch all around. Surface trims shall have the same width and height as the respective box. Doors and trims shall each be in one piece, so designed that doors will close without a rabbet.

D. Doors shall be fabricated from the same material as the cabinet trim and shall be fastened thereto by continuous concealed hinges. Doors shall be sized so that terminal blocks do not extend into the side, top or bottom gutter space. Doors shall be complete with flush type combination lock and catch with key. Doors over 48 inches high shall be provided with vault handles, built-in locks and three point catch fastening door at top, bottom and center. Terminal cabinets wider than 24 inches shall be provided with multiple doors as required. All terminal cabinets shall be keyed alike and shall be identical to panelboard keying.

E. Back-box interiors, inside trim, door and exterior shall be painted with rust inhibiting phosphatized coating after pickling. Door and exterior shall be finished in ANSI-61 grey enamel. Paint inside of door in accordance with system color as described in Section 16195.

F. Terminal cabinets shall be provided with 3/4 inch thick, fireproof plywood backboard finished with black insulating varnish with white art-board covering.

G. Terminal blocks shall be factory assembled; channel mounted, rated for 600 volts, with a separate continuous numbering system for each wiring function and shall be Square D, Class 9080 or equivalent.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Each terminal cabinet shall be labeled with an engraved laminated tag securely fastened to the exterior of the door, depicting the system name.

B. All wires shall be identified and terminated in a crimp type solderless lug and fastened under terminal screws.

C. All wiring in terminal cabinets shall be neatly racked and bundled with non-flammable nylon ties.

D. Terminate conduit in cabinet with locknut and insulated grounding bushings for feeders or locknut and insulated bushings for control and/or signal.

E. Provide a stick-on type wiring diagram mounted on the inside of the door of every terminal cabinet. The wiring diagram shall exactly duplicate all wiring and devices

installed in the terminal cabinet along with wire sizes and colors, color code legend, location where each wire originates and terminates, terminal strips, etc.

F. Provide an approved equipment ground bar in every terminal cabinet tied to local ground collection bus with a minimum #6 AWG CU THWN wire.

END 16133

PART 1 - GENERAL

1.01 WORK INCLUDES

A. Base Bid:

1. Electrical Contractor to provide:

a. Wiring devices as specified herein and indicated on the Drawings.

1.02 RELATED WORK

A. Specified elsewhere:

1. Drawings and general provisions of Contract, including, but not limited to, General, Special, and Supplementary Conditions and other Division - 1 Specification Sections, apply to the work of this Section.
2. Division 15 - applicable sections
3. Division 16 - applicable sections

1.03 SUBMITTALS

A. In accordance with Division 1.

1. Product Data: All wiring devices.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Materials shall conform to the following Schedule:

DEVICE AND RATING	NEMA CONFIG	ARROW HART	BRYANT	HUBBELL	PASS & SEYMOUR
20A, 125V Duplex, Surge Suppression Receptacle 2P, 3W Grounding	5-20R			8300H-5	6362-GRY SP
Toggle Switch 1P-20A, 120/277V, A.C.	---	1991	4901	1221	20AC1
Toggle Switch 3-Way, 20A, 120/277V, A.C.	---	1993	4903	1223	20AC3
Toggle Switch, 3 Pos. M.C. Center Off - 20A, 120/277V A.C. (Low voltage switching)	---	1995	4821	1557	1251
20A, 125V, duplex, General Purpose Receptacle, 2P, 3W Grounding	5-20R	5362	5362	8300I	5362

DEVICE AND RATING	NEMA CONFIG	ARROW HART	BRYANT	HUBBELL	PASS & SEYMOUR
20A, 125V Duplex Ground Fault Interrupter Receptacle	5-20R	GF5342	GFR53FT	9F8300I	2091-SH9
15A, 125V, 2P, 3W Clock Receptacle Stainless Steel Plate	5-15R	5708	2828-GS	5235	S3733SS

B. All switches and duplex receptacle shall have ivory finish.

C. All interior switch and outlet plates shall be Type 430 stainless steel to suit outlets installed, unless otherwise specified.

1. Multi-gang outlets shall be equipped with multi-gang device plates.

D. Weatherproof outlet plates shall be stainless steel with spring loaded gasketed doors.

E. Isolated ground receptacles shall be Hubbell IG5362 or approved equivalent.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Refer to Section 16130 for typical mounting heights of devices.

B. All switches and receptacles shall be flush mounted, where possible. All flush type outlets to be fitted with device plate that completely conceals opening. Use multiple gang plates where several devices are grouped. Receptacles for electric water coolers shall be concealed behind the unit.

C. Connect wiring device grounds in accordance with NEC requirements.

D. Locations shown are approximate. Determine exact locations at site by reference to building drawings and in conjunction with work by other trades. Coordinate location of devices in casework with Architect.

E. Exterior outlets shall be mounted horizontally.

END 16141

PART 1 - GENERAL

1.01 WORK INCLUDES

A. Base Bid:

1. Electrical Contractor to provide:

a. All disconnect switches for each motor and piece of electrically operated equipment shown on the Drawings or herein specified.

1.02 RELATED WORK

A. Specified elsewhere:

1. Drawings and general provisions of Contract, including, but not limited to, General, Special, and Supplementary Conditions and other Division-1 Specification Sections, apply to the work of this Section.
2. Division 15 - applicable sections
3. Division 16 - applicable sections

1.03 SUBMITTALS

A. In accordance with Division 1.

1. Product Data: All disconnect switches.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Provide switches, fusible or non-fusible as indicated. Switches shall be heavy duty, and incorporate a quick-make, quick-break operating mechanism. Cover shall be interlocked with handle and be suitable for padlocking in "OFF" position using up to three padlocks.

B. Switches shall be furnished in NEMA 1 general purpose enclosures unless specified as NEMA 3R on the plans. All switch enclosures installed outdoors shall be NEMA 3R (minimum) unless specified otherwise on the plans. Covers on NEMA 1 enclosures shall be attached with pin type hinges. NEMA 3R covers shall be securable in the open position. NEMA 3R enclosures for switches thru 200 amperes shall have provisions for interchangeable bolt-on hubs. NEMA 3R enclosures shall be manufactured from galvanized steel. Enclosures shall have a gray baked enamel finish, electrodeposited on cleaned, phosphatized steel.

C. Switches shall be horsepower rated for ac and/or dc as indicated by the plans. All fusible switches rated 100 thru 600 amperes at 240 volts and 30 thru 600 amperes at 600 volts shall have a UL approved method of field conversion from standard

Class H fuse spacing to Class J fuse spacing. The switch also must accept Class R fuses and have provisions for field installation of a UL listed rejection feature to reject all fuses except Class R. The UL listed short circuit rating of the switches shall be 200,000 rms symmetrical amperes when Class R or Class J fuses are used with the appropriate rejection scheme. The UL listed short circuit rating of the switch, when equipped with Class H fuses, shall be 10,000 rms symmetrical amperes. 800 and 1200 ampere switches shall have provisions for Class L fuses and shall have a UL listed short circuit range of 200,000 rms symmetrical amperes.

2.02 ACCEPTABLE MANUFACTURERS - Subject to meeting project requirements.

A. Square D
B. General Electric
C. Furnas
D. Cutler-Hammer
E. Siemens

PART 3 - EXECUTION

3.01 INSTALLATION

A. Mount switches so that the disconnect handle is 5 feet - 0 inches above the finished floor when at its highest point. Provide anchoring point at each mounting hole provided in enclosure.

B. Provide nameplate in accordance with Section 16050 to indicate equipment served or function of switch.

C. Provide oversized switch enclosures, lugs to satisfy conductor requirements, bending radius.

D. Provide fuse rejection clips in all switches.

E. Provide approved equipment ground bar in all units.

END 16170

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, bidding and contract requirements, including, but not necessarily limited to, General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Division 16 - All applicable sections.

C. Division 15 - All applicable sections.

1.02 DESCRIPTION OF WORK

A. Extent of electrical identification work is indicated by drawings and schedules.

B. Types of electrical identification work specified in this section include the following:

1. Electrical Power, Control and Communication Conductors
2. Equipment/System Identification Signs
3. Color Coding of System(s) Junction and Pull Boxes

1.03 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of electrical identification products of types required, whose products have been in satisfactory use in similar service for not less than three years.

B. NEC Compliance: Comply with NEC as applicable to installation of identifying labels and markers for wiring and equipment.

C. UL Compliance: Comply with applicable requirements of UL Standard 969, "Marking and Labeling Systems", pertaining to electrical identification systems.

D. NEMA Compliance: Comply with applicable requirements of NEMA Standard Numbers WC-1 and WC-2 pertaining to identification of power and control conductors.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's data on electrical identification materials and products.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide electrical identification products of one of the following (for each type marker):

1. Brady, W.H. Co.
2. Cole-Flex Corp.
3. Direct Safety Co.
4. George-Ingraham Corp.
5. Griffolyn Company
6. Ideal Industries, Inc.
7. LEM Products, Inc.
8. Markal Company
9. National Band and Tag Co.
10. Panduit Corp.
11. Seton Name Plate Co.
12. Tesa Corp.

2.02 ELECTRICAL IDENTIFICATION MATERIALS

A. General: Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is installer's option but provide single selection for each application.

B. Underground Type Plastic Line Marker: Provide manufacturer's standard permanent, bright-colored, continuous printed metallized mylar tape, intended for direct burial service; not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried cable.

C. Cable/Conductor Identification Bands: Provide manufacturer's standard vinyl cloth self-adhesive cable/conductor markers of wrap-around type, either pre-numbered plastic coated type, or write-on type with clear plastic self-adhesive cover flap; numbered to show circuit identification.

D. Engraved Plastic Laminate Signs: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in sizes and thicknesses indicated, engraved with engraver's standard letter style of sizes and wording indicated, black face and white core plies (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

1. Thickness: 1/16" for units up to 20 sq. in. or 8" length; 1/8" for larger units.

2. Fasteners: Self-tapping stainless steel screws, except contact type permanent adhesive where screws cannot or should not penetrate substrate.

2.03 LETTERING AND GRAPHICS

A. General: Coordinate names, abbreviations and other designations used in electrical identification work with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated for proper identification and

operation/maintenance of electrical systems and equipment. Comply with ANSI A13.1 pertaining to minimum sizes for letters and numbers.

PART 3 - EXECUTION

3.01 APPLICATION AND INSTALLATION

A. General Installation Requirements

1. Install electrical identification products as indicated, in accordance with manufacturer's written instruction and requirements of NEC.

2. Coordination: Where identification is to be applied to surfaces which require finish, install identification after completion of painting.

3. Regulations: Comply with governing regulations and request of governing authorities for identification of electrical work.

B. Underground Cable Identification

1. General: During backfilling/top-soiling of each exterior underground electrical signal or communication cable, install continuous underground type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in a common trench, and do not exceed an overall width of 16", install a single line marker.

2. Install line marker for every buried cable regardless of whether direct buried or protected in conduit.

C. Cable/Conductor Identification

1. General: Apply cable/conductor circuit identification on each cable/conductor in each box/enclosure/cabinet where wires are terminated.

D. Equipment/System Identification

1. General: Install engraved plastic laminate sign on each major unit of electrical equipment in building; including central or master unit of each electrical system, including communication/control/signal system, unless unit is specified with its own self-explanatory identification or signal system. Except as otherwise indicated, provide single line of text, 1/2" high lettering, on 1-1/2" high sign (2" high where 2 lines are required, white lettering in black field). Provide text matching terminology and numbering of the Contract Documents and shop drawings. Provide signs for each unit of the following categories of electrical work (including, but not limited to):

a. Panelboards, electrical cabinets, enclosures, terminal cabinets
b. Access panel/doors to electrical facilities
c. Major electrical switchgear

d. Power generating units
e. Telephone switching equipment
f. Fire alarm master station
g. Security monitoring master station
h. Terminal cabinets for all systems
i. Disconnect switches
j. Motor starters, contactors
k. Remote test stations for duct detectors

2. Install signs at locations indicated or, where not otherwise indicated, at location for most convenient viewing without interference with operation and maintenance of equipment. Secure to substrate with fasteners, except use adhesive where fasteners should not or cannot penetrate substrate.

E. Junction Box/Pull Box Color Coding

1. General: Inside and outside of electrical systems junction boxes to be painted as noted below to provide easy identification of systems:

a.	Emergency Power	Red
b.	Fire Alarm System	Red
c.	Security	Yellow
d.	DATA	Blue
e.	Telephone	Green

END 16195

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, bidding and contract requirements, including, but not necessarily limited to, General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Division 16 - All applicable sections.

1.02 DESCRIPTION OF WORK

A. Provide site electrical work to include excavating and backfilling as necessary for a complete exterior electrical system in accordance with drawings and specifications.

B. Extent of exterior electrical work underground is indicated on drawings and schedules.

C. Types of exterior electrical work underground in this section include the following:

1. Feeder duct-banks, exterior underground
2. Feeder duct-banks, under-slab or roadway conduit

D. Refer to other Division 16 sections for cable/wire and conduit work required in conjunction with this section.

1.03 QUALITY ASSURANCE

A. The work shall be performed in accordance with the NEC. Earthwork shall be in accordance with Section "Excavating, Trenching and Backfilling for Utilities" in Division 2.

B. NEC Compliance: Comply with NEC requirements as applicable to construction and installation of exterior electrical work underground.

C. NEMA Compliance: Comply with applicable requirements of NEMA Std. Publication.

1.04 COORDINATION

A. Prior to beginning trenching operations, exact locations and clearances for all underground work shall be established. Adjust position of underground utilities or adjust runs as necessary at no extra costs for proper coordination of other trades. Work shall be phased to minimize interference with other work performed under this Contract.

1.05 SUBMITTALS

A. Furnish shop drawings confirming all manhole/pull-box conduit openings, number of conduits, location, dimensions, etc.

B. Product Data: Submit manufacturer's data on manholes, pull-boxes, etc., including catalog cuts and mounting, installation requirements.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in work include, but are not limited to, the following:

1. Brooks Products, Inc.
2. U.S. Precast
3. Tri County Concrete

2.02 MANHOLES/PULLBOXES

A. Provide pre-cast units or built-up with minimum sizes as detailed on documents but no less than 6' x 6' x 6' deep body section. Furnish heavy duty traffic cover as required. All covers with beaded weld lettering indicating service. Provide all inserts for pulling irons, cable racks, etc. Provide sump pit and lifting eye or handle on covers. The final size of pre-cast unit shall be per conduit size, the NEC, and/or installation specifics. Provide all hardware, racks, etc. Racks shall be heavy duty non-metallic style as manufactured by Underground Devices, Inc., CR Series vertical member, RA Series arm.

PART 3 - EXECUTION

3.01 GENERAL

A. Do not excavate for electrical work until the work is ready to proceed without delay so that the total time lapse from excavation to completion of backfilling will be minimum.

B. The surface disturbed during the installation of duct or cable shall be restored to its original elevation and condition.

C. Maintain minimum cover requirements and provide concrete encasement as specified or shown.

D. Provide non-degradable metallized Mylar tape for duct-bank identification along entire run of duct-bank.

3.02 UNDERGROUND UTILITIES

A. Provide trenching and backfilling for all utility company feeders. Coordinate feeders. Coordinate trenching requirements with utility company.

B. Markers denoting utility company feeders shall be located at the beginning and ends of all runs, at approximately every 200 feet along the run, and at each change in direction, and in compliance with utility standard.

3.03 MANHOLES/HANDHOLES

A. Contractor shall neatly rack cabling around perimeter walls of box, not across center. Support from racks, lash to racks and keep cabling off bottom of box.

B. Provide conduit seals at each conduit entry into manhole/hand-hole to prevent dirt and water from entering raceway system.

C. Pitch conduits toward hand-holes to provide self-draining.

END 16411

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Includes:

1. Power system grounding for Services.
2. Grounding for Separately Derived Systems
3. Grounding for Control Circuitry.
4. Grounding for equipment.

1.02 RELATED WORK

A. Specified Elsewhere:

1. Drawings and general provisions of Contract, including, but not limited to, General, Special, and Supplementary Conditions and other Division - 1 Specification Sections, apply to the work of this Section.

2. Division 15 - applicable sections

3. Division 16 - applicable sections

1.03 SYSTEM DESCRIPTION

A. Grounding electrical service neutral at service entrance equipment to metal underground water pipe, metal frame of building and grounding rod.

B. Ground each separately derived system neutral to structural member of building.

C. Ground raceways and electrical equipment; use double locknuts at all panels; use bonding jumpers where conduits are installed in concentric knockouts. Ground panels, switches, motor frames, motor starters, and outlets with separate ground conductor in conduit system.

D. Bond together system neutrals, service entrance enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground terminals, building structural steel and plumbing systems.

1.04 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with NFPA 70, National Electric Code.
2. UL 467: Grounding and Bonding Equipment.

1.05 SUBMITTALS

A. In accordance with Division 1.

B. Test data in accordance with Section 16950.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Materials used for grounding conductors shall be in accordance with N.E.C. Article 250-91.

B. Ground Rods: Copper-Clad, 3/4 inch O.D. x 30'-0", min. or as noted.

C. Connections: Exothermic weld type.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Connect grounding electrode conductors to metal water pipe using a suitable ground clamp. Make connections to flanged piping at street side of meter. Provide bonding jumper around water meter.

B. Supplemental grounding electrode: Use driven ground rod where shown on drawings. Provide mechanical protection, Brooks boxes where shown on documents for accessibility to all ground rods.

C. Bond all grounding systems together.

D. Isolated grounding system (when applicable): Use insulated equipment grounding conductor and connect to service grounding electrode.

E. Separately Derived Systems: Provide connection to building steel bonded to neutral of transformer or other derived system source.

F. Where motors are connected to conduit system with flexible conduit section, install grounding conductor in flexible section.

3.02 FIELD QUALITY CONTROL

A. Measure ground resistance in accordance with Section 16950.

END 16450

PART 1 - GENERAL

1.01 WORK INCLUDES

A. Base Bid:

1. Electrical Contractor is to provide:

a. Panelboards herein specified and shown on the drawings.

1.02 RELATED WORK

A. Specified Elsewhere:

1. Drawings and general provisions of Contract, including, but not limited to, General, Special and Supplementary Conditions and other Division - 1 Specification Sections, apply to the work of this Section.
2. Division 15 - applicable sections
3. Division 16 - applicable sections

1.03 SUBMITTALS

A. In accordance with Division 1.

1. Shop Drawings: Panelboards
2. Product Data: Circuit breakers.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Panelboards rated 208Y/120 volt shall have copper bus structure braced for minimum, but not limited to, 10,000 RMS amps fault current, or as indicated on the drawings, whichever is greater. All copper parts shall be plated to prevent corrosion. Provide panelboards that are "fully rated" for the available short circuit amperes at the point of application.

1. All panelboards shall be Dead-Front Safety Type, equipped with thermal-magnetic molded case breakers, and solid neutral bus.

2. Bus bar connections to the branch circuit breakers shall be the "Distributed Phase" or "Phase Sequence" type. Bussing shall be such that adjacent single pole breakers will be on different phases or polarities, and that two or three pole breakers can be installed at any location.

3. Panelboard numbering shall be such that starting at the top, odd numbers shall be used in sequence down the left hand side and even numbers shall be used in sequence down the right hand side.

B. Cabinets shall be fabricated of code gauge galvanized steel with gutters per National Electrical Code. Fronts shall have doors with matching one piece trim, be code gauge and be finished with rust inhibiting primer and baked enamel. Fronts shall have adjustable indicating trim clamps completely concealed when door is closed. Provide a circuit directory frame and card with a clear plastic covering on the inside of the doors. Fronts shall have flush locks, and be furnished with two keys per lock.

C. Provide circuit breakers, quick-make, quick-break, thermal-magnetic, trip indicating, and common trip on all multi-pole breakers. Branch circuit breakers feeding convenience outlets shall have sensitive instantaneous trip settings of not more than 10 times the trip rating of the breaker. Circuit breakers shall have bolt-on connections to the bus. Ratings are shown on the panelboard schedule.

D. Main circuit breaker: Circuit breaker ampere rating as shown on drawings, 3-pole, single-throw, front connected, molded case, thermal-magnetic, common trip, quick-make, quick-break, adjustable magnetic trip elements, and minimum ampere RMS interrupting rating as specified. Provide where indicated on drawings.

E. Breakers intended to switch fluorescent lighting loads on a regular basis shall be rated for switching duty.

F. Provide ground fault circuit interrupter circuit breakers rated to trip at 30 milliamperes for circuits as shown on drawings.

G. Panelboards shall be furnished with ground bus and separate insulated neutral bus and a separate isolated ground bus.

H. Provide 200% rated neutral bus where shown on documents.

I. 208Y/120 Volt Panelboards:

1. Acceptable Products: Subject to meeting project requirements

a. G.E. Type AG
b. Square D Type NQOD
c. Cutler-Hammer PB
d. Siemens CDP-7

PART 3 - EXECUTION

3.01 INSTALLATION

A. Locate as shown on drawings. Maximum distance from floor to highest breaker: 6 feet - 6 inches.

B. Provide mounting materials required; make connections specified or shown. Use collars around mounting bolts, or equivalent means to provide 1/4" minimum air space between panel and wall for surface mounted panel.

C. Provide nameplate for each panel in accordance with 16050.

D. Provide typed circuit directory for each panel indicating load served. Leave spare circuit breakers and circuit breaker space blank on directory. Load served description shall indicate type, room or area designation, wattage ex: circuit 1 - Rooms 100, 101, 102, lighting, 1600W.

E. Where double-panels are indicated, provide single common trim or allow for two individual covers when mounting cabinets.

END 16471

PART 1 – GENERAL

1.01 WORK INCLUDES

A. Base Bid:

1. Electrical Contractor to provide:

a. Fuses for all fusible equipment installed on the project regardless of which contractor has provided the equipment.
b. Enclosed circuit breakers as indicated on the drawings and herein specified.

1.02 RELATED WORK

A. Specified Elsewhere:

1. Drawings and general provisions of Contract, including, but not limited to, General, Special, and Supplementary Conditions and other Division-1 Specification Sections, apply to the work of this Section.

2. Division 15 - applicable sections

3. Division 16 - applicable sections

1.03 SUBMITTALS

A. In accordance with Division 1.

1. Shop Drawings: Enclosed circuit breakers

2. Product Data

a. Fuses
b. Enclosed circuit breakers
c. Provide OCPD characteristic curves.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Fuses rated 601 amperes to 6000 amperes, 600 volt and below, shall be UL listed Class L current limiting type, 200,000 amperes, RMS interrupting.

1. Acceptable Products (subject to meeting project requirements)

a. Bussman Limitron - Type KLU
b. Little Fuse - Type KLLU
c. Gould Shawmut- Type A4B

B. Fuses rated 15 to 600 ampere (except for motor branch circuit protection), 600 volt and below, UL listed Class RK-1 current limiting type, 200,000 amperes RMS interrupting.

1. Acceptable Products

a. Bussman Limitron - Type KTS-R
b. Little Fuse - Type KLSR
c. Gould Shawmut - Type A2K (250 VAC)/A6K (600 VAC)

C. Fuses for motor branch circuit and transformer protection U.L. listed Class RK-5 dual element type, 200,000 amperes RMS interrupting.

1. Acceptable Products

a. Bussman Fusetron - Type FRS-R
b. Little Fuse - Slo-Blo, Type FLS-R
c. Gould Shawmut - Type TR (250 VAC)/TRS (600 VAC)

D. Furnish and install individually enclosed circuit breakers as indicated on the plans. All circuit breakers shall meet Federal Specification W-C-375B, and both the circuit breaker and the enclosure shall be UL listed.

Circuit breakers shall have over-center toggle type mechanisms, providing quick-make, quick-break action. Breakers shall have current and interrupting rating as indicated on the plans. Each circuit breaker shall have trip indication by handle position and shall be trip-free. Two and three pole breakers shall be common trip. Each breaker shall have a permanent trip unit containing individual thermal and magnetic trip elements in each pole.

Neutrals shall be furnished in devices as indicated on the plans. Neutrals shall be insulated and are to be groundable for use in service entrance applications.

Enclosures shall be of the NEMA type indicated on the plans.

NEMA 1 enclosures shall be furnished with knockouts where practical and shall be fabricated from sheet steel which conforms to UL 50. The enclosure shall be given an electrodeposited, gray baked enamel finish. Padlocking provisions shall be provided to allow locking the circuit breaker in the "OFF" position. Enclosures shall be UL listed.

NEMA 3R enclosures for circuit breakers rated through the 225 ampere frame size shall be furnished with provisions for interchangeable, bolt-on hubs. Enclosures shall be fabricated from galvanized steel and shall be given an electrodeposited, gray baked enamel finish. Enclosure covers shall be securable in the open position. Padlocking provisions shall be provided to allow locking the enclosure cover closed. Enclosures shall be UL listed.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Fused distribution system is designed to provide selectivity, coordination, and component protection. To guarantee this system, all fuses shall be from the same manufacturer. Substitution provisions are specified in Division 1.

B. Place a fuse identification label showing size and type of fuses installed inside the cover of each switch.

C. Furnish Owner at completion of project, one spare set (3) of each size of fuse rated over 600 amperes, and 10 percent spare fuses of each size and type rated 600 amperes or less, but not less than three. Obtain a written receipt for same from the Owner.

D. Provide a nameplate for each enclosed circuit breaker in accordance with Section 16050.

END 16475

PART 1 – GENERAL

1.01 WORK INCLUDES

A. Base Bid:

1. Electrical Contractor to provide:

a. All motor starters and controllers as shown on the drawings and as required to complete all power wiring to motor loads and miscellaneous mounting hardware.

1.02 RELATED WORK

A. Specified Elsewhere:

1. Drawings and general provisions of Contract, including, but not limited to, General, Special, and Supplementary Conditions and other Division - 1 Specification Sections, apply to the work of this Section.

2. Division 15 - applicable sections

3. Division 16 - applicable sections

1.03 SUBMITTALS

A. In accordance with Division 1.

1. Shop Drawings: All motors starters and enclosures.
2. Product Data: All components.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Fractional horsepower manual motor starters shall be single pole toggle type with thermal overload protection and trip free operation. Provide starter in NEMA 1 flush or surface enclosure unless otherwise specified or required. Provide red pilot light.

1. Acceptable Products: (subject to meeting project requirements)

a. G.E. - CR101
b. Square D - Class 2510
c. Cutler-Hammer - B200
d. Furnas - Class 10
e. Siemens - MSF

B. Combination magnetic starters shall be across-the-line fusible type. Disconnect shall be front operated, capable of being locked in the open position and have cover

interlocked with handle. Starters shall be NEMA rated for the horsepower loads at the rated voltage and shall include a control transformer with primary and secondary fuse protection and a 120 volt fused control circuit external manual reset, and 3 overloads. Provide under-voltage protection, loss of phase and phase reversal, (for motors of 1½ HP and greater). Phase failure and under voltage relay shall have adjustable response time delay. Provide adjustable time delay relay (0 - 10 minutes) for start-up after power failure to allow stagger starts and minimize inrush on system. Enclosure shall be NEMA 1 unless otherwise specified or required.

1. Acceptable Products: (Subject to meeting project requirements)

    a. G.E. - CR308
    b. Square D - Class 8538
    c. Furnas - Class 18
    d. Siemens - SCB

C. Each combination starter shall be furnished with a minimum of one N.O. and one N.C. auxiliary contact for spare or future purposes (this is additional to required active auxiliary contacts).

D. Provide motor starters with 'hand-off-auto' selector switches and 'red-run' indicating pilot light.

E. Connections to the selector switch shall be such that only the normal automatic regulatory control devices will be bypassed when the switch is in the "hand" position. All safety control devices, such as low and high pressure cutouts, high temperature cutouts, and motor overload protective devices, life safety/fire alarm controls shall be connected in the motor control circuit in both the "hand" and the "automatic" positions.

F. Provide approved equipment ground lugs in all equipment.

G. Variable Speed Motor Controllers: Variable frequency type controllers shall be furnished for motors as indicated by VFD on the drawings. The controllers shall be designed to operate from a 208 volt (+10%-5%) or 480 volt (+10%-5%), three-phase, 60 hertz power supply and control a squirrel cage motor with a corresponding voltage rating. Unit shall be rated for the necessary horsepower as per the manufacturer's criteria, and controller shall be furnished with motor circuit protector (MCP). Controller shall be rated to operate in an ambient temperature 0 degrees C. to 40 degrees C. continuously and shall be capable of supplying 150% of rated full load current for one minute at maximum ambient temperature. Controller shall not cause displacement power factor of less than .95 lagging, under any speed and load condition. Acceleration and deceleration time shall be independently field adjustable from 1.5 seconds to 20 seconds. (Set at 10 seconds). Controller shall be capable of producing an output frequency over the range of 2 to 60 hertz without low speed cogging. Over frequency protection shall be provided such that a failure in the electronic circuitry shall not cause the frequency output to exceed 110% of maximum output frequency (66 hertz).

Maximum and minimum output frequency shall be field adjustable. Maximum frequency adjustment: 43 hertz to 60 hertz (set at 60 hertz). Minimum frequency adjustment: 2 hertz to 30 hertz (set at 30 hertz).

The variable speed motor controller shall be a 12-pulse unit. However, if a 6-pulse unit is used, the unit shall be provided with integral harmonic filters to mitigate the harmonic distortion on the power system.

The controller shall accept a speed reference signal to change speeds by either a 4-20 ma or 0-10V of speed reference signal. Provide a bi-metal overload relay. The controller electronics shall contain light emitting diodes (LED's) to monitor and indicate status of drive and conditions causing drive failure. Controller shall be provided with an isolation contactor to electrically isolate the drive from the motor feeder. Provide auto re-start function (ability to be actuated from remote location) and auto shut-down of unit following fault. Door mounted accessories shall include a Hand-Off-Auto Selector Switch, start/stop control, manual speed potentiometer, digital speed meter (designating output Hertz), drive run light (Red Lens) and drive failure light (Amber Lens). All components of the controller to be housed in a wall or floor mounted NEMA Type 1 enclosure.

1. Controllers shall be housed in wall or floor mounted enclosures as required and designed to operate in ambient temperature of 0 degrees to 40 degrees C.

2. Contractor shall include the services of a factory trained technician to inspect final connections, make field adjustments and initial start-up of all variable frequency controllers, and provide two days of training for maintenance personnel.

3. Acceptable Products:

   a. ASEA Brown Boveri
   b. Magnetek
   c. Square D
   d. Siemens

PART 3 – EXECUTION

3.01 INSTALLATION

A. Furnish overloads based on the nameplate rating of the motor to be controlled.

B. Each motor shall be supplied by an individual branch circuit in separate branch conduit, except where otherwise shown.

C. All final connections to motor shall be made with flexible conduit, not less than 18 inches or more than 24 inches long. Provide ground wire to motor frame. Conduit shall be adequately supported at each motor.

D. Proper direction of rotation of all motors shall be the responsibility of this Contractor.

E. All disconnects, combination starters, starters, and control devices, etc., shall have nameplates or legends indicating the equipment served and/or the functions of the device. These nameplates or legends shall be sized relative to the device, be made of engraved phenolic compound, and properly secured to the device. Refer to Section 16050.

F. It is understood that motor sizes called for in schedules and locations of same are for estimating purposes only, and it shall be the responsibility of the Contractor for work under this Section to confer with the Contractors of other trades involved and provide connections of proper capacity at proper locations thereof. This Contractor shall be fully responsible to furnish and install proper fuses, starters, conduit, thermal heaters and conductors to the individual starters, leaving same ready for operation.

G. Where starters and other devices are furnished with the equipment, this Contractor shall receive these starters and other devices in connection with the units and do all necessary power field wiring between equipment and starters. This work is to be done under the supervision of the respective Contractor, or Subcontractor, who shall be fully responsible for providing adequate and correct wiring diagrams and instructions.

H. Install motor starters as follows:

1. Location: Approximately as shown. Choose precise location to provide ample space for operation and maintenance; confirm with Architect/Engineer.

2. Mounting Method:

   a. Wall Mounting: Use expansion anchors and bolts. Install collars around mounting bolts, to provide air space between wall and device enclosure.

   b. Structural Steel Mountings: Bolt to steel or brackets welded to steel. Provide air space between steel and device enclosure.

   c. Angle Iron Framework Mounting: Provide where walls or structural steel not available. Bolt device enclosure or enclosures to angle iron or to steel panel attached to iron as directed.

   d. Floor Mounting: Install on 4" high concrete equipment pad, in a plumb and level manner. Use expansion anchors and bolts as required.

3. Painting: Refer to Division 9.

END 16480

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes transfer switches rated 600 V and less and the following items:

1. Automatic transfer switch.
2. Remote annunciation system.
3. Remote annunciation and control system.

1.03 SUBMITTALS

A. Product Data: For each switch specified. Include dimensioned plans, sections, and elevations showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and materials lists.

B. Wiring Diagrams: Details of wiring for transfer switches and differentiating between manufacturer-installed and field-installed wiring. Show both power and control wiring.

C. Single-Line Diagram: For each combined transfer switch, show connections between transfer switch, power sources, and load; and show interlocking provisions.

D. Product Certificates: Signed by manufacturer certifying that products furnished comply with requirements and that switches have been tested for short-circuit closing and withstand ratings applicable to units for Project.

E. Qualification Data: For firms and persons specified in the "Quality Assurance" Article.

F. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

G. Maintenance Data: For each type of product to include in the maintenance manuals specified in Division 1. Include all features and operating sequences, both automatic and manual. List all factory settings of relays and provide relay-setting and calibration instructions.

1.04 QUALITY ASSURANCE

A. Testing Agency Qualifications: In addition to requirements specified in Division 1 Section "Quality Control," an independent testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or shall be a full member company of the InterNational Electrical Testing Association.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or National Institute for Certification in Engineering Technologies, to supervise on-site testing specified in Part 3.

B. Emergency Service: Manufacturer maintains a service center capable of providing emergency maintenance and repairs at Project site with an 8-hour maximum response time.

C. Source Limitations: Obtain automatic transfer switch, remote annunciators, and remote annunciator and control panels from a single manufacturer who assumes responsibility for all components.

D. Listing and Labeling: Provide transfer switches specified in this Section that are listed and labeled for emergency service under UL 1008.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

E. Comply with NFPA 70.

F. Comply with NFPA 99.

G. Comply with NFPA 110.

H. Comply with NEMA ICS 1.

I. UL Compliance: Comply with UL 1008, "Automatic Transfer Switches," unless requirements of these Specifications are stricter.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Conventional Transfer Switches:

a. Caterpillar, Inc.; Engine Division.
b. Emerson Electric Co.; Automatic Switch Co. Subsidiary.
c. Generac Power Systems, Inc.
d. Kohler Power Systems; Generator Division.

e. Onan/Cummins Power Generation; Industrial Business Group.
f. Russelectric, Inc.
g. GE Zenith Controls.
h. Spectrum Detriot Diesel.

2. Transfer Switches Using Molded-Case Switches or Circuit Breakers:

a. Eaton Electrical Inc.; Cutler-Hammer.
b. Lake Shore Electric Corp.
c. GE Zenith Controls.

2.02 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Units Smaller than 600 A: Listed without derating for all classes and all mixtures of classes of loads, including 100 percent tungsten filament lamp or 100 percent inductive load.

B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated based on testing according to UL 1008.

1. Where External Circuit Breaker or Fuses Protect Transfer Switch: Products are listed for use with the actual devices providing the fault-current protection at each location for Project. Rated fault-current, withstand-duration times include the following:

a. Units Protected by Molded-Case Circuit Breakers 150 A and Less: 1.5 cycles.
b. Units Protected by Molded-Case Circuit Breakers Larger than 150 A: 3 cycles.
c. Units Protected by Power and Insulated-Case Circuit Breakers: 10 cycles.
d. Units Protected by Current-Limiting Fuses: 0.5 cycles (nominal).

2. Where Transfer Switch Includes Internal Protection: Rating of switch and trip unit combination exceeds indicated fault-current value at installation location.

C. Annunciation and Control Interface Components: Devices at transfer switches for communicating with remote annunciators or annunciator and control panels have communications capability matched with the remote device.

D. Solid-State Controls: Repetitive accuracy of all settings is plus or minus 2 percent or better over an operating temperature range of minus 20 deg C to 70 deg C.

E. Resistance to Damage by Voltage Transients: Components meet or exceed voltage-surge withstand capability requirements when tested according to ANSI C37.90.1. Components meet or exceed voltage-impulse withstand test of NEMA ICS 1.

F. Neutral Terminal: Where 2- or 3-pole switches are indicated, provide fully rated, solid, unswitched neutral terminal, unless otherwise indicated.

G. Four-Pole Switches: Where 4-pole switches are indicated, provide neutral switching.

H. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of the circuit in which the switch is installed.

I. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6; UL 508, unless otherwise indicated.

J. Heater: Equip switches exposed to outdoor temperature and humidity conditions, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater.

K. Factory Wiring: Train and bundle factory wiring and label consistent with Shop Drawings, either by color code or by numbered or lettered wire and cable tape markers at terminations.

1. Designated Terminals: Pressure type suitable for types and sizes of field wiring indicated.

2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.

3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

L. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid or electric motor-operated mechanism, mechanically and electrically interlocked in both directions.

M. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switch or insulated-case circuit-breaker components and switches using contactors not designed for continuous-duty repetitive switching between active power sources are not acceptable.

2. Switch Action: Double throw; mechanically held in both directions.

3. Switch Contacts: Silver composition for load current switching. Conventional automatic transfer-switch units rated 225 A and greater have separate arcing contacts.

2.03 AUTOMATIC TRANSFER SWITCH

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Manual Switch Operation: Manually operated under load, with the door closed, and with either or both sources energized. Transfer time is the same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

D. Signal-before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

E. Digital Communications Interface: Full-duplex RS 422 type, matched to capability of remote annunciator or annunciator and control panel.

F. Transfer Switches Based on Molded-Case Switch Components: Comply with UL 489, UL 869, and NEMA AB 1.

2.04 AUTOMATIC TRANSFER-SWITCH FEATURES

A. Voltage sensing for each phase of normal source. Pickup voltage is adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.

B. Time delay for override of normal-source voltage sensing delays transfer and engine start signals. Adjustable 0 to 6 seconds and factory set at 1 second.

C. Voltage/Frequency Lockout Relay: Prevents premature transfer to an emergency generator set. Pickup voltage is adjustable from 85 to 100 percent of nominal. Factory set to pickup at 90 percent. Pickup frequency is adjustable from 90 to 100 percent of nominal. Factory set to pickup at 95 percent.

D. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes and factory set at 10 minutes. Provides automatic defeat of the delay on loss of voltage or sustained under-voltage of the emergency source, provided normal supply has been restored.

E. Test Switch: Simulates normal-source failure.

F. Switch-Position Pilot Lights: Indicate source to which load is connected.

G. Source-Available Indicating Lights: Supervise sources via the transfer-switch, normal- and emergency-source sensing circuits.

1. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."

2. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

H. Unassigned Auxiliary Contacts: 2 normally open single-pole, double-throw contacts for each switch position, rated 10 A at 240 V, ac.

I. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of the condition of the normal source. A pilot light indicates override status.

J. Engine Starting Contacts: 1 isolated, normally closed and 1 isolated, normally open. Contacts are gold flashed or gold plated and rated 10 A at 32 V, dc minimum.

K. Engine Shutdown Contacts: Instantaneous. Initiates shutdown sequence at remote engine-generator controls after retransfer of load to normal source.

L. Engine Shutdown Contacts: Time delay adjustable from 0 to 5 minutes; factory set at 5 minutes. Initiates shutdown at remote engine-generator controls after retransfer of load to normal source.

M. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine-generator set and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory-set periods are for 7 days, 20 minutes, and 5 minutes, respectively. Exerciser features include the following:

1. Exerciser Transfer Selector Switch: Permits selection between exercise with and without load transfer.

2. Push-button programming control with digital display of settings.

3. Integral battery operation of time switch when normal control power is not available.

2.05 REMOTE ANNUNCIATOR SYSTEM

A. Functional Description: Remote annunciator panel annunciates conditions at indicated transfer switches. Annunciation includes the following:

1. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
2. Switch position.
3. Switch in test mode.
4. Failure of digital communications link.

B. Annunciator Panel: LED-lamp type with audible signal and silencing switch.

1. Indicating Lights: Grouped for each transfer switch monitored.

2. Label each group indicating the transfer switch it monitors, location of switch, and identity of load it serves.

3. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.

4. Lamp Test: Push-to-test or lamp test switch on front panel.

2.06 REMOTE ANNUNCIATOR AND CONTROL SYSTEM

A. Functional Description: A remote annunciation and control panel provides the following functions at indicated transfer switches:

1. Sources-available indication, as defined by actual pickup and dropout settings of transfer-switch controls.
2. Switch-position indication.
3. Switch in test-mode indication.
4. Failure of digital-communications-link indication.
5. Key-switch or user-code access to control functions of panel.
6. Control of switch-test initiation.
7. Control of switch operation in either direction.
8. Control of time-delay bypass for transfer to normal source.

B. Annunciation and Control Panel: Solid-state components. Include the following features:

1. Controls and indicating lights grouped together for each transfer switch.

2. Label each indicating light "Control Group." Indicate the transfer switch it controls, location of switch, and load it serves.

3. Digital Communications Capability: Matched to that of transfer switches supervised.

4. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.

C. Malfunction of annunciator unit or communications link does not affect functions of automatic transfer switch. In the event of failure of the communications link, the automatic transfer switch automatically reverts to stand-alone, self-contained operation. No automatic transfer-switch sensing, controlling, or operating function depends on the remote panel for proper operation.

2.7 FINISHES

A. Enclosures: Manufacturer's standard enamel over corrosion-resistant pretreatment and primer.

2.8 SOURCE QUALITY CONTROL

A. Factory Test Components, Assembled Switches, and Associated Equipment: Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Wall Mounting of Switches: Level and anchor unit to wall.

B. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.

C. Identify components according to Division 16 Section "Electrical Identification."

D. Identify components according to Division 16 Section "Basic Electrical Materials and Methods."

3.02 WIRING TO REMOTE COMPONENTS

A. Match type and number of cables and conductors to control and communications requirements of transfer switches used. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

3.03 CONNECTIONS

A. Ground equipment as indicated and required by National Electrical Code.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.04 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing agency to perform specified acceptance testing.

B. Testing Agency: Provide the services of a qualified independent testing agency to perform specified acceptance testing.

C. Preliminary Tests: Perform electrical tests as recommended by manufacturer and as follows:

1. Measure phase-to-phase and phase-to-ground insulation resistance levels with insulation resistance tester. Include external annunciator and control circuits. Use test voltages and procedure recommended by manufacturer. Meet manufacturer's specified minimum resistance.

2. Check for electrical continuity of circuits and for short circuits.

D. Field Tests: Give 7 days' advance notice of tests and perform tests in presence of Owner's representative.

E. Coordinate tests with tests of generator plant and run them concurrently.

F. Tests: As recommended by manufacturer and as follows:

1. Contact Resistance Test: Measure resistance of power contacts for automatic transfer switches. Resolve values in excess of 500 micro-ohms and differences between adjacent poles exceeding 50 percent.

2. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices to ensure sensors are properly selected and located to optimize ground-fault protection when power is being delivered from either source.

   a. Verify grounding points and sensor ratings and locations.
   b. Apply simulated fault current at sensors and observe reaction of circuit-interrupting devices.

3. Operational Tests: Demonstrate interlocking sequence and operational function for each switch at least 3 times.

   a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
   b. Simulate low phase-to-ground voltage for each phase of normal source to automatic transfer switches.
   c. Verify time-delay settings and pickup and dropout voltages.

G. Test Failures: Correct deficiencies identified by tests and prepare for retest. Verify that equipment meets specified requirements.

H. Reports: Maintain a written record of observations and tests. Report defective materials and workmanship and retest corrected items. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.05 DEMONSTRATION

A. Training: Engage a factory-authorized service representative to instruct Owner's personnel in the operation, maintenance, and adjustment of transfer switches and related equipment. Provide a minimum of 8 hours of instruction scheduled 7 days in advance.

END 16495

PART 1 - GENERAL

1.01 WORK INCLUDES

A. Base Bid:

1. Electrical Contractor to provide:

a. All lighting fixtures as indicated in the "Lighting Fixture Schedule", complete with lamps, all wiring and connections, all required mounting hardware, frames, and proper labels for fabrication and wiring.
b. Low voltage switching system.
c. Dimming systems.

1.02 RELATED WORK

A. Specified Elsewhere:

1. Drawings and general provisions of Contract, including, but not limited to, General, Special, and Supplementary Conditions and other Division - 1 Specification Sections, apply to the work of this Section.

2. Division 15 - applicable sections

3. Division 16 - applicable sections

1.03 REFERENCES

A. Certified Ballast Manufacturer's (CBM)

B. Electrical Testing Laboratories (ETL)

C. Underwriters' Laboratories Inc. (UL)

D. National Electrical Code (NEC) - NFPA 70

1.04 SUBMITTALS

A. In accordance with Division 1.

B. Manufacturer's product data, marked as necessary to indicate materials and equipment being provided, for light fixtures, including lamps, ballasts (electronic) and photometric data; bind in brochure form (3 ring binder). Each fixture cut-sheet shall clearly identify the catalog number, lamp style number, ballast catalog number. Submit technical data on each ballast including harmonic distortion, crest factor, etc. Cite any deviations from plans and specifications clearly on each submission for reviewers ease.

C. Shop Drawings: Complete low voltage switching panels, interconnection and wiring diagrams, poles, bases certifying rated wind load characteristics, dimming system data, risers, wiring diagrams.

D. In accordance with Division 1. Operations and Maintenance Data: Low voltage switching system.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Lighting Fixtures: Types as designated in the "Lighting Fixture Schedule" on drawings. Provide fixtures complete with all required accessories. Contractor shall coordinate with Architectural documents and provide fixtures complete with ratings, hardware, and accessories in his bid.

B. Lamps: Types and ratings as shown in the "Lighting Fixture Schedule".

1. Incandescent: Inside frosted, general service or reflector. Lamps rated 130 volts. Place new lamps in all incandescent fixtures immediately prior to acceptance of project.

2. Fluorescent: Octron T8 F032 energy saving type, except where specifically indicated otherwise. All lamps for this project shall of the same manufacturer.

a. Where color rendition lamps are specified, lamps shall be on common manufacturer and processing batch.

3. Metal Halide: Clear bulb, mogul base.

4. Acceptable Manufacturers:

a. General Electric
b. North American Philips
c. Osram-Sylvania

C. Ballasts: (Types and ratings as shown on the lighting fixture schedule)

1. Fluorescent (Energy Saving Type): High power factor, CBM certified, ETL rated, UL listed, Class P, sound rating "A", energy saving type.

2. Fluorescent (Electronic Type): High power factor (90% minimum), U.L. listed, sound rating "A", operate lamps at a frequency of 25 to 35 kHz with no detectable flicker, fully potted in steel case and contain no PCB's, surge and transient protected to 6,000 volts, EMI and RFI protected within FCC requirements. Ballasts shall provide for soft stable start of rapid start lamps and maintain cathode heat during operation. Ballasts with parallel circuit operation shall permit other lamps to continue functioning after one lamp has failed. Provide five year warranty.

a. Magnetek-Triad
b. Motorola

3. HID: Constant wattage auto-transformer or regulator, high power factor type. Provide fuse block and fuse for protection of ballast. Fixture manufacturer shall select exact arrangement of fuse protection.

D. Wiring: Provide conduit and conductors per drawings or system requirements. Fixture wiring shall comply with fixture manufacturer's recommendations and NEC requirements.

E. Mounting Hardware: Provide steel needed to supplement building structure for support of fixtures. Supports shall be capable of supporting 300 percent fixture and lamp weight. Fixtures shall not be supported from ductwork, piping, or ceiling wires.

2.02 EMERGENCY LIGHTING SYSTEM

A. Emergency lighting system consists of selected fixtures as indicated on Drawings.

B. Fixtures: As designated in the "Lighting Fixture Schedule" on Drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Place fixtures per architectural reflected ceiling plans. Modify to avoid other equipment or structural components. Each fixture shall be securely supported from the structure. Provide 4 fixture tie wires, clips for each troffer independent of ceiling tie wires. Support per ceiling manufacturer recommendation, UL.

B. Pendant fixtures shall be supported from self-aligning stems or chain hangers furnished by the fixture manufacturer and cut to the proper length for the mounting height.

C. Provide necessary conduit, wire, fittings, mounting hardware and miscellaneous materials to locate fixtures in unobstructed locations.

D. Coordinate installation of lighting fixtures with work of other trades. Verify exact location of fixtures with respect to suspended ceiling layout to achieve uniformity.

E. Provide a rustproof plaster frame for every fixture recessed in a plaster ceiling. Frame shall be of the flush trim type.

F. At the time of final inspection the lighting system shall be complete and clean. Any damage prior to final inspection and noted during final inspection shall be replaced or repaired by the Contractor at no cost to the Owner.

G. All lamps used for construction lighting shall be replaced prior to acceptance.

H. Provide fuse protection for each phase leg on all fluorescent and hid fixtures, interior and exterior.

END 16500

1 GENERAL

1.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this Section.

1.2 Division-16: Basic Electrical Materials and Methods Sections apply to work of this Section.

1.3 All Drawings and Specifications of all divisions of the contract documents are complementary to each other and what is called for by one shall be as binding as if called for by both. If a discrepancy exists, the higher cost shall be bid and the architect and engineer shall be notified.

1.4 This specification provides requirements for complete and working copper and fiber optic structured cabling systems intended for voice or data. All components provided shall be capable of performing to minimum of Category 6E performance.

1.5 Submittals

1.5.1 Submit shop drawings with detail sufficient to establish compliance with contract documents. Mark all data sheets for the product being provided with an identifying mark or arrow. Submit operator's manuals for all instrumentation proposed for use in testing.

1.5.2 Submit shop drawings on IBM-PC compatible compact disk (CD) in AutoCAD-2007 or 2010 formats. Drawings shall include the following:

1.5.2.1 Floor plans showing locations of computer/telephone terminal outlets, raceway, cable tray and conduit, communications rooms and cabinets, and all outlet numbers shall be indicated. Floor plans shall be accurately drawn to 1/4" = 1'-0" scale or other standard scale. Plans obtained from architect or engineer may be used as background with irrelevant features removed as necessary for clarity.

1.5.2.2 Elevations of all new equipment racks and back boards, and/or existing racks and boards being renovated, containing new equipment shall be indicated. Elevations shall be accurately drawn to ½" = 1'-0" scale. All new and existing equipment shall be identified with make, model number, and outlet number served.

1.5.2.3 A complete riser diagram of the renovated system with all items fully identified as above shall be indicated in submittal.

1.5.2.4 Submittal shall include – but shall not be limited to - providing the following:

1.5.2.4.1 Submit a complete parts list of data communications equipment with manufacturers part numbers included before, during and after the completion of job.

1.5.2.4.2 Submit manufacturers catalog information showing dimensions, technical information and configuration. Provide data for the following: Wire and cable specifications, Raceways and fittings, Connectors, outlets, jacks and other required hardware, Termination components for each type, Fiber Optic patch panels, Fiber Optic patch cords, and Distribution frames.

1.5.2.4.3 Submit manufacturer's technical data sheet for cabling to include the following: Mutual Capacitance (pf/ft), Cable length Impedance, Attenuation, Worst and best pair to pair near end cross talk and DC Resistance.

1.5.3 Contractor shall make all submittals described above and receive engineer's review before proceeding with work. Drawings described in 1.5.2 through 1.5.2.4.3, above, are a required part of the shop drawing submittal.

1.5.4 Prior to Substantial Completion, the Contractor shall test and inspect the new system equipment, devices, and cabling to ensure that it is in compliance with these documents. Deficient workmanship, including incorrect labeling, may be considered sufficiently serious to bar substantial completion. Prior to requesting a substantial completion inspection, contractor shall submit the following:

1.5.4.1 Submit test reports for all new copper and fiber optic cables and their terminations verifying connectivity in compliance with existing system labeling and data transmission in compliance with applicable standards. Reports shall bear a statement that the renovations to the system complies with the contract documents and referenced standards in all respects and shall be signed by a current BICSI RCDD. Submittal shall include properly executed manufacturer warranty document as described paragraph 1.7, below. Submit two weeks prior to request for substantial completion inspection. Submit no test reports showing marginal or failing test results.

1.5.4.2 Manufacturer's warranty as described in 1.7, below, shall be included.

1.5.5 Modify drawings prepared in 1.5.2 through 1.5.2.4.3, above, to reflect as-built condition and submit as part of as-built drawings package.

1.6 Coordination of all work with owner and with providers of telephone and data equipment to be used with system provided under this specification shall be performed by the Contractor as part of satisfying the requirements of the Contract Documents. Where work by the Owner or others are required in conjunction with construction, Contractor is responsible for coordinating such work and ensuring that all required work is completed on schedule. Coordinate the location of all items with all other documents in the contract and with job conditions. Exact locations of equipment provided in the existing

telecommunications room(s) (labeled, "TELE/COMM" on the Drawings) shall be approved by Owner prior to rough-in.

1.7 Warranty and Contractor Qualifications: In addition to warranty coverage required elsewhere in the contact documents. Contractor shall obtain from manufacturer(s) of signal connectivity equipment 15 year minimum warranty guaranteeing system performance level(s) specified herein. Manufacturer warranty shall be coordinated among the various manufacturers of cable, jacks, receptacles and other components involved to provide a single point of responsibility. Manufacturer warranty shall provide all materials and labor necessary to correct deficiencies without pro-ration over the life of the warranty. Bid shall fully explain conditions of warranty, including remedies, limitations and any and all conditions requiring owner compliance. Shop drawings submittal shall include documentary evidence that contractor will be using installers certified by manufacturer as necessary to obtain warranty. Companies specializing in manufacturing products specified in this section will have a minimum of 3 years experience. The contractor shall be experienced in all aspects of the work to be performed. Including as part of the contractors bid, the contractor will disclose all subcontractors that will be utilized, to include the names of the subcontractor(s), list of completed jobs of equal size, resume of the project foreman, RCDD documentation and other supporting documentation.

1.8 Codes and Standards, as indicated below, shall be considered additional requirements of this Contract for Construction where applicable. Work performed as part of this contract shall be in accordance with relevant sections of TIA/EIA 568, 569 and 606, Building Industry Consulting Services, International Standards (now just BICSI: A Telecommunications Association), the National Electrical Code, (NFPA-70), Life Safety Code (NFPA-101), and the Florida Building Code. Specific editions of these codes shall be as adopted by the local authority having jurisdiction over this work. Special amendments to these codes and other requirements of the local fire and building authorities having jurisdiction over this work shall also apply.

1.8.1 Workmanship shall conform to the highest standards of BICSI and EIA/TIA. Finished work shall be of the required quality and present a neat and orderly appearance. Non-conforming work shall be corrected to the Owner's and engineer's satisfaction at no change in the contract amount.

2 PRODUCTS

2.1 All products proposed for use shall be new, unused and undamaged, UL approved for the intended use and in compliance with the contract documents. Non-conforming material shall be removed from the work site and replaced promptly.

2.2 Fire-safing and sleeve materials used for passage of raceways and cabling through rated fire and smoke partitions shall be of a type and configuration

acceptable to the fire protection and building inspection authorities having jurisdiction over this work and shall comply with architectural sections of these contract documents.

2.3 Any item of equipment or material not specifically addressed on the contract documents required to provide a complete and functional system shall be provided in conformance with the contract documents.

2.4 All cables and connections provided under this contract for data (not telephone) shall be rated category 6E and shall be terminated per EIA/TIA 568A unless specifically stated as otherwise.

2.5 Optical Fiber Cabling shall be multimode optical fiber cables of 62.5/125µm type and shall meet all of the requirements delineated within the specifications of ANSI/TIA/EIA-568-1 and ISO/IEC 11801 and shall be provided with a plenum rated outer jacket. Single-mode optical fiber cables shall be 8.7-10/125µm type and shall be provided with a plenum rated outer jacket. (Belden, Berk-Tek, Commscope. General Cable, Mohawk, Optical Cable Corporation, or approved equal).

2.6 ST Connectors shall provide the following minimum requirements: 0.3dB Attenuation, less than 02dB per 1000 reconnects, and with Zirconia Ceramic tip/nickel plated zinc body and 125 Micron size. Shall be 3-M Hot Melt Multimode 6100, 3-M Hot Melt Single-mode 8100 YS or approved equal.

2.7 19" Equipment Racks shall be provided as necessary (reuse existing where possible) and shall have (3in) vertical cable channels as side rails and (7ft) height and have standard ANSI/EIA-310-C mounting holes having 45 rack mount spaces minimum on front and back of rails. Cable routing opening shall be available in the front and rear of the channels. Racks shall have ladder channel which acts as a top bracket to easily nest a standard 304.8 mm (12in) ladder tray. The channel must have carriage bolt holes for attaching to the ladder system. Racks shall be aluminum with a black finish. Racks shall have vertical cable management channels located between racks. Racks shall have floor mounting holes and a ground lug for #6 ground conductors provided. Racks shall be fastened with proper fasteners to floor. Front and rear cable management shall be at the top of each rack.

2.8 Category 6E Data Cables shall be manufactured by Belden, Berk-Tek, Commscope, General Cable, Mohawk, or approved equal. All category 6E cables and connectors shall comply with EIA/TIA-568 (designation T568A). Cable shall be unshielded twisted pair (UTP) and be rated for a minimum of 100 mbps (ANSI X3T9.5.). Each pair shall have a twist that ranges from 12 to 24 twists per foot. Outer jacket shall be of Plenum rated (CMP) material: PVC (CMR) jacket cabling shall not be used. Network cables shall be secured to walls, construction frame work or appropriate tie downs within the existing telecom room and at the new or existing IDF/MDF backboard(s). Horizontal cabling above the ceiling shall be secured on J-hooks using

approved methods and devices; no cables shall be lying on or otherwise unsecured above the ceiling. Data network cable outer jackets shall be 1st grey and yellow 2nd with UL listed markings visible. The following manufacturers shall be approved: AT&T Systemax, General Cable, Mohawk, and Berk-Tek.

2.9 Voice communication cables will be CAT 6E 4-pair or higher. Voice station cables shall be terminated on 66M Blocks or 110 style block located in the existing TELE/COMM locations indicated on the drawings. The station cable will be BLUE in color and terminated to a 568A standard jack at the user end unless otherwise stated herein. All station cable pairs shall be terminated. Multiple pair cables such as 25 pair shall be used to extend or connect voice systems to interconnect buildings as necessary. Point to point connections indoors will be made using CAT 6E multiple copper pair plenum rated outer jacket 24 or 26 gauge cable.

2.10 Outdoor underground cabling (when applicable) will be done in such a manner that all cables are installed with the appropriate sized conduit. Underground copper cables shall be filled with moisture resistant material. The interconnecting cables will be terminated on a 66M block that has integrated lightning protection on each end of the cables. Each end of the buried cable will be grounded using proper size clamps.

2.11 110 Cross Connect Blocks: Wall mounted ATT type 110 wiring block with 4 pair ATT type 110C connecting blocks. Ortronics 110 Wiring Blocks and 110C Connecting Blocks or approved equal.

2.12 Category 6E Patch Cords with termination types required shall be provided for all patch panel locations with colors to match the related cable types for voice and data. Each patch cord shall be uniquely identified from all other patch cords in each room using typed, heat shrink labels at both ends. Patch cords shall be provided complete from manufacturer and shall not be assembled, labeled or otherwise fabricated in the field. User end patch cords shall be 7 feet long, and telecommunications closet end shall be 3 feet long.

2.13 Patch Cords for Fiber Optic cables shall be pre-assembled multimode 62.5/125 micron duplex fiber optic cable with four ST style connectors and shall have plenum rated outer jacket. Cable shall be 10 feet in length. Cable ends shall be labeled on both transmit and receive ends. Provide 1 patch cord for every fiber optic interface card provided in the distribution frame. Provide additional spare cords totaling 5% of the number of interface cards provided.

2.14 Fiber Optic Terminal Cabinets - All fiber optic cabling shall be terminated on existing or new rack mounted cabinet installed on the existing or new Telecommunications rack. Fiber patch panel shall be 12 to 24 strand rack mounted for ST connectors. Provide rack mounted fiber termination patch panels capable of handling 24 ST fiber connectors. Each panel shall contain

2 components, one for organizing the cable's individual pairs and the other for user access to the equipment side of each ST connector. Panels shall be constructed of high galvanized steel with stainless steel hardware and a painted corrosion resistant enamel black finish. Enclosures shall have 2 interlocking doors with a means to lock each cabinet. Provide 2 keys for each cabinet. All holes shall have grommets.

2.15 Patch Panels for Voice shall be Category 6E 48-port patch panel with front RJ-45 jacks and rear 110 type connectors color coded for 568A wiring. Power Sum compliant and tested to 350 MHz, mounted in steel frame designed for standard 19 inch equipment rack mounting and not more than 3 rack units high. Provide with integral labels front and rear and rear wire management bar. Ports on each panel shall be arranged in two rows of four groups each with six ports in each group.

2.16 Patch Panels for Data shall be Category 6E 48-port patch panel with RJ-45 jacks, Power Sum compliant and tested to 350 MHz, mounted in steel frame designed for standard 19 inch equipment rack mounting and not more than 3 rack units high. Provide with integral labels front and rear and rear wire management bar. Ports on each panel shall be arranged in two rows of four groups each with six ports in each group.

2.16.1 Cable Management Panel shall be painted steel panel for standard 19" rack mounting with five 3" x 4" cable management rings for management of horizontal cable bundle.

2.17 At each and every wall-mounted Data/Telephone outlet shown on the plans provide materials and labor as follows:

2.17.1 Provide a 4-11/16" square 2-1/8"deep steel junction box flush mounted in wall 18" AFF with single gang plaster ring. Coordinate exact location and mounting height with architect's documents. Provide 1" EMT from junction box to be stubbed to above the ceiling with an insulated bushing at its end. Furthermore, all conduits stubbed above the ceiling shall end in a bend which turns so that the conduit is horizontal at its end. All turns shall be sweep ells or pull points. Provide pull boxes as specified by Section 16130 except that pull boxes shall be provided as necessary to ensure that no more than two 90° bends (or 180° total bending if bends are less than 90°) are provided between any two pull points. Label the conduit end with an engraved phenolic tag identifying the room and outlet served as described below:

2.17.2 Provide four-module single-gang faceplate with two category 6E modular RJ-45 jacks grey and yellow color for data and with two category 6E modular RJ-45 jacks with blue color for voice outlets. Provide blank module covers as necessary to close all faceplates. Ports 1 and 2 shall be data, and ports 3 and 4 shall be voice utilizing the blue and orange pair for port 3 and utilizing green and brown pair of same telephone cable for port 4.

2.18 At each and every Computer/Telephone Terminal Outlet provide the following:

2.18.1 Provide one 4-pair Category 6E cable terminated to each Cat 6E jack except those for voice (one cable shall be shared for two voice jacks). Extend cables through conduit and along J-hook system to punch down blocks in the existing telecommunications room and terminate there. Provide fifteen feet of spare length per cable neatly secured. Cables outside conduit shall be bundled by outlet and by room with Velcro type straps on three foot centers and supported by J-hooks. Fasteners which may indent cable jacket are specifically forbidden. Attach a type written shrink fit sleeve type label to both ends of each cable bearing the color code of the jack and the number of the outlet and room consistent with the other labeling specified. Labels shall not be hand written or adhesively attached. Cables shall extend from room jack to punch down block in phone/computer room continuously without splice or joint.

2.18.2 Provide type written identifying label on faceplate bearing the outlet room and sequence number. Label shall be slip-in type, mechanically secured by a transparent label as provided with faceplate. Adhesive labels are not acceptable. Outlet room number shall be per building room numbering plan and shall match permanent room number. Outlets within room shall be numbered sequentially staring with 1 and proceeding clockwise around room from entry door. Start numbering at door closest to northwest corner of room in rooms with multiple doors. Outlets on islands within rooms shall be numbered after all wall outlets, shall be sequential within each piece of casework, row or group of floor outlets and shall proceed from north to south and west to east. Coordinate numbering with engineer as necessary; see other labeling requirements below. Enter all outlet numbers on field record and as-built drawings. Match the existing outlet identification system as necessary.

2.19 In the existing telecommunications room labeled "TELE/COMM", on the drawings, Contractor shall provide materials and labor necessary to provide the following:

2.19.1 Provide eight feet high ¾" thick plywood back boards as necessary for new equipment installations. Install back board panels to support 500 pounds per sheet with a 1 foot moment arm. Paint with two coats of fire retardant gray paint. Provide cutouts as necessary for building systems.

2.19.2 Where necessary, provide screw type copper ground bus bar with #6 copper radial connections to all installed equipment, raceway and connecting communications and power feeders and branch circuits. All grounds must be radial without loop through, joint or splice. Daisy-chain grounds are specifically forbidden.

2.19.3 Utilize existing cable trays or provide new cable trays as may be shown on the drawings and as necessary to support all cables. Suspend cable tray from ceiling with its bottom eight feet above finished floor using 1/2 inch rods on two foot centers. Rods shall be attached the cable tray at the midpoint of its width. Rods attached to the rails will block cable access to the tray and are not acceptable. Rod attachments to the cable tray shall be sufficiently rigid as to prevent perceptible tipping of the tray with loads up to its maximum rating applied to one rail. Entire cable tray installation shall be made using components supplied by cable tray manufacturer; field fabrications shall not be used.

2.19.4 As required for the number of outlets supplied, provide 48-port metal modular patch panels mounted in 19" x 7' equipment racks or provide the equivalent stand-off-bracket wall-mounted patch panels if no equipment racks are existing or shown on the Drawings. Provide full vertical and horizontal wire management. Provide materials and labor as necessary to fully color code and label all patch panels and jumper cables. Select colors to match jacks served. Coordinate panel organization and labeling with owner.

2.19.5 Provide one (1) PC5E06Y booted six feet long Category 6E eight conductor patch cords with RJ-45 plugs for each RJ-45 jack provided on the Drawings as specified above. Patch cords shall match that of the jacks to which they are connected. All patch cords shall be uniquely identified with shrink-sleeve or other permanently affixed label at each end.

2.19.6 Provide 24-port optic rack-mount enclosures with ST adapter panels or provide equivalent wall-mounted optic rack-mount enclosure with bracket if no equipment racks are existing or otherwise shown on Drawings. Provide terminated fiber optic duplex jumpers 3 meters long to connect fiber optic interface to owner's equipment as necessary. Coordinate exact lengths and adapter requirements with owner.

2.20 All labels shall be neatly type written or engraved and shall be mechanically secured in place. Hand written, adhesive or otherwise defective labels shall be replaced at no change in the contract amount.

3 EXECUTION

3.1 Each room outlet, termination, connector block and cable shall be tested to verify both the electrical characteristics and correctness of the termination sequence and labeling. Testing connections shall be made to modular jacks at the outlets and at the patch panels. Electric characteristic tests shall include cross talk and other interference, attenuation impedances and reflections and bit error rate, all at 100 Base-T data rates. Notify engineer and owner and provide complete technical data regarding proposed test equipment, connections and methods two weeks prior to testing. Test only with engineer present or with engineer's written instructions to proceed. Perform all tests and submit test data verifying satisfactory performance to

engineer and to owner prior to substantial completion. All tests shall be performed by or under the direct supervision of a BICSI RCDD employed by the Contractor. All test reports shall he signed by the responsible RCDD and shall bear the RCDD's written statement that all components of the system were found to fully meet all requirements of the contract documents in all respects.

3.2 Contractor shall coordinate all work with the owner.

3.3 Contractor shall be responsible for providing complete and working system of cables, outlets, terminations and other necessary equipment for the data system.

3.4 Show conduit and wire way routing, ends and pull points on drawings. Cable length between Data/phone outlet and termination in equipment in IDF shall not exceed 300 feet. Advise engineer at once of any raceway or cable run which cannot be constructed within this limit.

3.5 Provide a sufficient quantity of patch panels on equipment racks in the IDF/MDF room to terminate the cable runs to the room. Provide one cable management panel below each patch panel as necessary.

3.6 Provide sufficient length at each cable end to circle each room once at the walls or thirty feet, whichever is less. Monitor pulling tension at all times and maintain below manufacturer's maximum. Remove and replace all over tensioned cables. Maintain bend radius at or above manufacturer's minimum at all times. Remove and replace all cables bent to less than manufacturer's minimum bend radius. Remove and replace all cable showing jacket damage. Label both ends of all conduits, inner ducts and cables at both ends, as described elsewhere in this specification, with the room number of the opposite end.

3.7 Provide a sufficient number of SM fiber optic cabinets on back boards in MDF and the IDF room to terminate all OSP distribution fiber optic strands.

3.8 Cables outside conduit shall be bundled by outlet and by room with Velcro type straps on one foot centers. Fasteners which may indent cable jacket are specifically forbidden. Attach a type written slip-on or shrink-fit sleeve type label to both ends of each terminated cable bearing the number of the outlet. Labels shall not be hand written or adhesively attached. Cables shall extend from telephone/data outlet to termination locations in one continuous piece without splice, joint or intermediate termination.

3.9 Labels shall be neatly type written or engraved and shall be mechanically secured in place. Hand written, adhesive or otherwise defective labels shall be replaced at no change in the contract amount. Provide type written identifying label on faceplate of each Data/phone outlet and each patch panel bearing the outlet Room and sequence number. Label shall be slip-in type,

mechanically secured by a transparent label as provided with faceplate. All Data/phone outlet faceplates, cables, jacks and all conduit, cables and jacks in tele/comm locations shall he labeled as shown on numbering plan. If no numbering plan is provided on documents, number as follows: Match existing or outlet room number shall match permanent room number. Outlets within room shall be numbered sequentially starting with 1 and proceeding clockwise around room from entry door. Start numbering at door closest to northwest corner of room in rooms with multiple doors. Outlets on islands within rooms shall be numbered after all wall outlets, shall be sequential within each piece of casework, row or group of floor outlets and shall proceed from north to south and west to east. Enter all outlet numbers on field record and as-built drawings. Color code jacks in faceplates and duplicate all Data/phone outlet numbers and color code on MDF and IDF labels. Utilize Communications labeling standard. This is a 4 digit system, 1st number identifies the floor that it is on, 2nd number will identify the patch panel number 1, 2, 3, 4 etc. 3rd is the exact port number on the patch panel. For example, labeling at a workstation would state 1201, for the first port and 1202, for second port on the faceplate left to right. Voice will be labeled in ascending order from top to bottom on the existing or new 66M block. Coordinate exact labeling requirements with Owner prior to performing labeling work.

3.10 Provide eight feet high ¾" thick plywood back boards as necessary for new equipment installations. Install back board panels to support 500 pounds per sheet with a 1 foot moment arm. Smooth all edges and surfaces and apply two coats of fire retardant gray paint. Provide cutouts as necessary for building systems.

3.11 Where necessary, provide screw type copper ground bus bar with #6 copper radial connections to all installed equipment, raceway and connecting communications and power feeders and branch circuits. All grounds must be radial without loop through, joint or splice. Loop through or daisy-chain grounds are specifically forbidden. Ground all equipment racks.

3.12 Utilize existing cable trays or provide new cable trays as may be shown on the drawings and as necessary to support all cables. Suspend cable tray from structural ceiling with its bottom eight feet above finished floor using ½ inch rods and stiffener bars on each on two foot centers and at each end. Rods shall be attached to the cable tray at the midpoint of its width. Rods attached to side rails will block cable access to the tray and are not acceptable. Rod attachments to the cable tray shall be sufficiently rigid as to prevent perceptible tipping of the tray with loads up to its maximum rating applied to one rail. Entire cable tray installation shall be made using components supplied by cable tray manufacturer; field fabrications shall not be used. Cable tray shall be center beam aluminum ladder type four inches deep with ½" square minimum cross section rungs on 9" centers with end caps. Provide 12 inches of tray width for every two equipment racks, 12' minimum.

3.13 Secure equipment racks to floor slab with bolts and washers of the maximum size to fit mounting holes in base. Provide a minimum of four bolts epoxy grouted into 2" deep holes in slab. Allow epoxy to cure completely before mounting equipment in racks. Locate racks with 3 feet minimum clearance front and 5 feet clearance back. Coordinate exact location with owner. Locate all in-slab conduit, pipes aid other interferences before drilling slab.

3.14 All workmanship shall be of the highest quality available in the Industry and comply in all respects with the requirements of the codes and standards cited earlier. Workmanship shall conform to the highest standards of BICSI and EIA/TIA. Finished work shall be of the required quality and present a neat and orderly appearance. Non-conforming work shall be corrected to the Owner's and Engineer's satisfaction at no change in the contract amount.

3.15 Each room outlet, termination, connector block and terminated cable shall be tested to verify both the electrical characteristics and correctness of the termination sequence and labeling. Testing connections shall be made to modular jacks at the outlets and at the patch panels. Tests shall include length, cross talk and ACR at both ends, attenuation by power meter, impedances and reflections and bit error rate, all at 100 Base-T data rates. Cross talk and impedance measurements do not apply to fiber optic cables. Notify engineer and owner and provide complete technical data regarding proposed test equipment, connections and methods two weeks prior to testing. Test only with engineer present or with engineer's written instructions to proceed. Perform all tests and submit test data verifying satisfactory performance to engineer and to owner prior to substantial completion. Submit no reports showing failed or marginal test results. All tests shall be performed by or under the direct supervision of a BICSI RCDD employed by the Contractor or his sub-contractor. All test reports shall be signed by the responsible RCDD and shall bear the RCDD's written statement that all components of he system were tested and found to fully meet all requirements' of the contract documents in all respects. Report shall individually name all tests or standards applied and cite compliance with each individually. Parts or all of this testing may be included in any testing required for manufacturer's warranty, provided the testing requirements in this section are met.

END OF SECTION

PART 1 - GENERAL

1.01 WORK INCLUDES

A. Base Bid:

1. Electrical Contractor to provide:

a. Electrically operated, electrically supervised, microprocessor controlled, intelligent reporting, fire alarm system as indicated on the Drawings and specified herein. System shall include but not be limited to, alarm initiating and indicating devices, control relays, conduit, wire, fittings, testing and accessories as necessary to match and be compatible with the existing fire alarm system and control panel, to provide a complete operating system. Contractor shall relocate existing devices as indicated or necessary and shall provide and install new devices and equipment as required to match the existing fire alarm system. Contractor shall re-certify the system in accordance with NFPA-72 upon completion of the renovations.

2. Fire Alarm Contractor to provide:

a. Auxiliary alarm switches.
b. Supervisory switches.

3. Temperature Control Contractor to provide:

a. Control of all smoke dampers (where applicable).

4. General Contractor to provide:

a. Magnetic door holders (where applicable).

1.02 RELATED WORK

A. Specified Elsewhere:

1. Drawings and general provisions of Contract, including, but not limited to, General, Special, and Supplementary Conditions and other Division-1 Specification Sections, apply to the work of this Section.
2. Division 15 - applicable sections
3. Division 16 - applicable sections

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:

1. National Electrical Code, (NEC): Comply with NFPA 70.
2. National Fire Protection Association, (NFPA):

a. 72 – Protective Signaling Systems
b. 90A – Installation of Air Conditioning and Ventilating Systems
c. 101 – Life Safety Code

3. Uniform Fire Code, 1991.

a. UL Applicable Requirements
b. ADA 1990

4. Factory Mutual Applicable Requirements

1.04 SUBMITTALS

A. Submit in accordance with Division 1.

B. Product Data: All system components.

C. Shop Drawings: (Submit as a single package)

1. Provide manufacturer's names, model numbers, ratings, power requirements, equipment layout, device arrangement, conduit layouts for all new devices and equipment. Provide updated annunciator layout, configurations and terminations.

2. Wiring diagrams indicating the method of wiring for each new alarm initiating and signaling circuit and each control circuit. Provide complete system interconnection diagram indicating existing and new wiring types, sizes and terminations, terminal cabinet details, point-to-point.

3. Submit wiring diagrams showing internal wiring. Provide clear, concise description of operation that gives in detail the information, procedures to operate system.

D. In accordance with Division 1 Operations and Maintenance: Complete manual to fully describe operation and maintenance of the Fire Alarm and Detection System.

1.05 SYSTEM DESCRIPTION

A. The deliberate act of pulling a manual alarm station, or the automatic operation of a smoke detector, heat detector or flow switch shall cause the following functions to occur.

1. Continuously sound all audible and visual alarm devices until system has been reset. It shall be possible to silence the alarm signals at the existing fire alarm panel.

2. Visually indicate on the existing control panel and existing annunciator an alarm condition by device. The visual alarm indicator shall remain locked in until the system has been manually reset. Indicate via 80 character LCD display all

information associated with the fire alarm condition including descriptor and location.

3. Printing and history storage equipment shall log the information.

4. Transmit alarm signal to existing FACP panel that will auto-dial on-site monitoring panel. Confirm that existing on-site monitoring panel will auto-dial offsite agency.

B. Closing of shut-off valves on fire protection sprinkler system shall indicate trouble condition. All tamper switches shall be annunciated by zone.

C. Basic Performance:

1. Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded onto an NFPA Class A signaling line circuit.

2. Initiation device circuits shall be wired Class B.

3. Indicating appliance circuits shall be wired Class B.

4. Digitized electronic signals shall employ check digits or multiple polling.

5. A single ground or open on the system Signaling Line Circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.

6. Alarm signals arriving at the existing main FACP shall not be lost following a power failure (or outage) until the alarm signal is processed and recorded.

1.06 SOFTWARE MODIFICATIONS

A. Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes. Response time of the technician to the site shall not exceed 4 hours.

B. Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm system on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made.

1.07 CERTIFICATIONS

A. Together with the shop drawing submittal, submit a certification from the major equipment manufacturer indicating that the proposed supervisor of installation and the proposed performer of contract maintenance is an authorized representative of

the major equipment manufacturer. Include names and addresses in the certification.

1.08 GUARANTY

A. All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least one (1) year from the date of acceptance by the State Fire Marshall. The full cost of maintenance, labor and materials required to correct any defect during this one year period shall be included in the submittal bid.

1.09 POST CONTRACT MAINTENANCE:

A. Complete maintenance and repair service for the fire alarm system shall be available from a factory trained authorized representative of the manufacturer of the major equipment for a period of five (5) years after expiration of the guaranty.

B. As part of the submittal, include a quote for a maintenance contract to provide all maintenance, test, and repair described below. Include also a quote of unscheduled maintenance/repair, including hourly rates for technicians trained on this equipment, and response travel costs. Submittals that do not identify all post contract maintenance costs will not be accepted. Rates and costs shall be valid for the period of five (5) years after expiration of the guaranty.

C. Maintenance and testing shall be on a semiannual basis or as required by the local authority having jurisdiction. A preventive maintenance schedule shall be provided by the Contractor that shall describe the protocol for preventive maintenance. The schedule shall include:

1. Systematic examination, adjustment and cleaning of all detectors, manual fire alarm stations, control panels, power supplies, relays, water flow switches and all accessories of the fire alarm system.

2. Each circuit in the fire alarm system shall be tested semiannually.

3. Each smoke detector shall be tested in accordance with the requirements of NFPA 72.

PART 2 - PRODUCTS

2.01 MATERIALS

A. The existing Fire Alarm Control Panel (FACP) shall remain in service and be reused.

B. Panel shall be manufacturer's standard surface mounted enclosure with hinged, key locked cover. Panel shall be Underwriters Laboratories Inc., listed.

1. Acceptable Products: (Subject to meeting project requirements)

a. Silent Knight (to match and be compatible with the existing system)

C. Addressable manual pull stations shall be single action non-coded, with normally open (N.O.) contacts, pull lever to break glass rod type, key-reset feature, red color semi-flush mounting.

D. Audio/Visual alarm signals shall be a combination alarm horn and high intensity xenon flashers. Signals shall operate from a 24 volt d.c. source. Sound level shall be 88 db at 10 feet. Visual unit shall have white lexan lens with red letters labeled "FIRE". Units shall be flush mounted with red grille covers. Provide single or double horn projectors as shown on the drawings. Provide weatherproof housing for exterior horns. Provide indicating alarm devices that meet ADA criteria for intensity, rate, etc.

E. Intelligent, addressable heat detectors shall be combination fixed temperature and rate of rise type with normally open (N.O.) contacts. Rate of rise shall be approximately 15 deg. F. per minute. Fixed temperature shall be approximately 135 deg. F. in normal occupancies and approximately 200 degrees F. in high temperature spaces.

F. Intelligent, addressable smoke detectors shall be dual chamber, light obscuration photoelectric type with normal open (N.O.) alarm contacts and normally closed (N.C.) trouble contacts. Detectors shall have an LED to indicate normal and alarm conditions and have provision for testing. Detectors shall be plug-in type with a separate base. Units shall be self compensating via software.

G. Intelligent, addressable air duct smoke detectors shall be photoelectric type with housing for mounting directly on a duct to detect products of combustion in the ducts of air handling systems. Provide air sampling tubes to span the entire width of duct. Detector shall operate at 24 Vdc and have remote test-reset key switch with alarm light (LED). Detector shall operate as part of the fire alarm system. Duct mounted smoke detectors shall initiate a signal through the existing FACP to de-energize air handlers and close respective smoke dampers. Coordinate with Division 15 documents and contractor.

H. Provide all auxiliary relays as required to perform the functions specified herein.

I. Provide addressable monitor, control modules to satisfy system functions.

J. Provide loop isolation modules for loop protection, minimum of 1/floor.

K. Furnish and install all wiring, components and appurtenances necessary to implement functions as required.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation shall be in accordance with the NEC, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.

B. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

C. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

D. All Equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

3.02 CONDUIT AND WIRE

A. Conduit

1. Conduit shall be in accordance with The National Electrical Code (NEC), local and state requirements.

2. Where possible, all wiring shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.

3. Cable must be separated from any open conductors of Power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, as per NEC Article 760.

4. Wiring for 24 volt control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.

5. Conduit shall not enter the existing Fire Alarm Control Panel, or any other remotely mounted Control Panel equipment or back-boxes, except where conduit entry is specified by the FACP manufacturer.

6. Conduit shall be 3/4 inch (19.1 mm) minimum.

B. Wire

1. All fire alarm system wiring shall be new.

2. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the existing fire alarm system. Number and size of conductors shall be as recommended by the existing fire alarm system manufacturer, but not less than 18 AWG (1.02 mm) for Initiating Device Circuits and Signaling Line Circuits, and 14 AWG (1.63 mm) for Indicating Appliance Circuits.

3. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.

4. All wire and cable shall be installed in metallic conduit. No PVC shall be utilized.

5. Wiring used for the multiplex communication loop shall be twisted and shielded and installed in conduit unless specifically excepted by the existing fire alarm equipment manufacturer. The system shall permit use of IDC and IAC wiring in the same conduit with the communication loop.

6. All field wiring shall be completely supervised.

C. Terminal Boxes, Junction Boxes and Cabinets

All boxes and cabinets shall be UL listed for their use and purpose.

D. Initiating circuits shall be arranged to serve like categories (manual, smoke, water flow). Mixed category circuitry shall not be permitted except on signaling line circuits connected to intelligent reporting devices.

E. The existing Fire Alarm Control Panel should be connected to a separate dedicated branch circuit, maximum 20 amperes. This circuit should be labeled at the Main Power Distribution Panel as FIRE ALARM. Existing Fire Alarm Control Panel Primary Power wiring should be 12 AWG. The existing Control Panel Cabinet should be grounded securely to either a cold water pipe or grounding rod. The Circuit Breaker should be painted red and provide lock. Contractor shall field verify the status of the existing Fire Alarm Control Panel conditions and shall correct any deficiencies noted as necessary to comply with NFPA 72 and the authority having jurisdiction.

3.03 TESTING

A. Provide the service of a competent, factory-trained engineer or technician authorized by the manufacturer of the existing fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system. Representative must be state certified fire alarm installer.

1. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.

2. Close each sprinkler system flow valve and verify proper supervisory alarm at the existing FACP.

3. Verify activation of all flow switches.

4. Open initiating device circuits and verify that the trouble signal actuates.

5. Open and short signaling line circuits and verify that the trouble signal actuates.

6. Open and short indicating appliance circuits and verify that trouble signal actuates.

7. Ground all circuits and verify response of trouble signals.

8. Check presence and audibility of tone at all alarm notification devices.

9. Check installation, supervision, and operation of all intelligent smoke detectors using the Walk Test.

10. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the existing FACP and the correct activation of the control points.

11. When the existing system is equipped with optional features, the manufacturer's manual should be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.

12. Final testing shall be in the presence of the State Fire Marshall and warranty shall begin on date of acceptance by State Fire Marshall.

3.04 FINAL INSPECTION

A. At the final inspection a factory trained representative of the manufacturer of the major equipment shall demonstrate that the systems function properly in every respect. Representative shall be a state certified fire alarm installer.

3.05 INSTRUCTION

A. Provide instruction as required for operating the system. "Hands-on" demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided.

B. The Contractor and/or the Systems Manufacturer's representatives shall provide a typewritten "Sequence of Operation" to the Owner.

C. Contractor shall provide a permanent graphical plaque at the existing building FACP, framed, to indicate floor plan, fire alarm device locations, address and descriptor for ease of alarm location. Also provide framed sequence of operation at the existing FACP location.

END 16721

PART 1 - GENERAL

1.01 WORK INCLUDES

A. Base Bid:

1. Electrical Contractor to provide:

a. Testing of electrical components and equipment as herein specified.

1.02 RELATED WORK

A. Specified Elsewhere

1. Drawings and general provisions of Contract, including, but not limited to, General, Special, and Supplementary Conditions and other Division - 1 Specification Sections, apply to the work of this Section.

2. Division 15 - applicable sections

3. Division 16 - applicable sections

1.03 SYSTEM DESCRIPTION

A. Testing includes:

1. Resistance tests.
2. Continuity tests.
3. Phase relationship verification.
4. Voltage tests.
5. Medium voltage cable hi-pot.
6. Ground fault protection tests.
7. Operation of the Emergency System Transfer Switch.

1.04 QUALITY ASSURANCE

A. Regulatory Requirement

1. Comply with the National Electrical Code, NFPA 70.
2. NFPA 101.

B. Testing authority shall be certified and qualified in electrical testing procedures. Provide experience and resume with bid proposal.

1.05 SUBMITTALS

A. Test Reports: All test reports shall be submitted in triplicate, assembled and bound, to Architect/Engineer prior to final acceptance.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Furnish all test equipment to perform specified testing.

B. Contractor shall certify and maintain accuracy of all test equipment used on this project for testing.

PART 3 - EXECUTION

3.01 TESTS

A. Conduct such tests and adjustment of equipment as necessary to verify performance requirements.

B. Test Reports: Typewritten, listing testing equipment used, person or persons performing the tests, date tested, circuits tested, motor or equipment nameplate data, and results of tests.

C. Insulation resistance tests general:

1. Perform insulation resistance tests on equipment and cables listed herein.
2. Test equipment: Furnished by Contractor.
3. Resistance measured; line-to-ground.
4. Disconnect, prior to testing, any device that could be damaged by application of voltage.

D. Insulation resistance tests shall be conducted per following schedule:

Item Tested	Voltage of Test	Min. Acceptance Resistance in Megohms
No. 2 and larger cables (600 V)	1000V	50
Motors	500V	5
Switchboards, Motor Control Centers and Panelboard Buses	1000V	25
Step-down Transformers	500V	5

E. Ground Resistance

1. Measure and record ground resistance from system neutral connection at service entrance to convenient ground reference point using suitable ground testing equipment. Minimum acceptable resistance: 10 ohms. When resistance exceeds 10 ohms, drive and bond another ground rod, one ground rod length away and repeat test.

F. Continuity Test

1. Test branch circuits and control circuits to determine continuity of wiring and connection. Submit written statement that this has been performed.

2. Test security power, control and communications circuit to determine continuity of wiring.

G. Voltage test shall be made and recorded at the following listed points. Tests shall be conducted under normal load conditions.

1. Service entrance at main disconnect switch.
2. Secondary terminals of all step down transformers (when applicable).
3. Terminals of all motors.

H. Phase Relationship: Check connections to equipment for proper A-B-C phase relationships. Verify proper motor relation.

1. Disconnect, prior to check, any device that could be damaged by the application of voltage of reversed phase sequence.

I. Phase Balancing: Contractor shall balance phase loadings to substantially allow equivalent currents across all phases. Check all panels, switchboards, and adjust for balancing by circuit rearrangement. Issue report and as-built.

J. Test isolated ground system to certify isolation integrity.

3.02 CORRECTIONS OF DEFECTS

A. If tests disclose any unsatisfactory workmanship or equipment furnished under this contract, Contractor shall repair or replace such defects immediately without additional cost.

B. If any wiring or equipment is damaged by tests, Contractor shall repair or replace such wiring or equipment immediately without additional cost.

C. Upon correction of defects, Contractor shall re-test until proper results are obtained.

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